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A REVISION OF THE SPECIES IN *AGROMYZA* FALLEN,  
AND *CERODONTA* RONDANI. (DIPTERA).

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The work on the two genera presented in this paper has been undertaken for the purpose of deciding the identity and distinctions of several species affecting field and forage crops, upon which considerable work has been done by the field agents of the division dealing with the insects affecting these crops. In some cases it has been found necessary to change the names of certain American species, as examination has proved that they are either synonymous with other American species or with species belonging to the European fauna. In the case of some other species it may at some future time become necessary to sink the American species as synonymous with European forms, but owing to the most unsatisfactory condition of the knowledge of the species contained in this family (*Agromyzidæ*) in Europe, it is not possible to definitely decide upon the correct names of their species from the brief descriptions available. Thus, while I suspect the distinctness of certain species in our fauna from others occurring in Europe, I consider it the safer plan, and one entailing no material disadvantages, to retain those species in our list, rather than rank them as synonyms of species which may ultimately prove to be absent from our fauna.

Generic Characters of *Agromyzæ*.

Head of normal size; frons broad, from one-third to a little over one-half the head width; ocelli on a slightly raised portion of the ocellar triangle, so distinct in the *Oscinidæ*, seldom traceable; orbits distinct, 3-5 pairs of orbital bristles present anterior to front ocellus; one pair of bristles on ocellar region slightly behind anterior ocellus, pointing forward and slightly divergent, vertical row consisting of two central divergent and two outer convergent bristles; postvertical bristles divergent; face nearly straight in vertical outline, or slightly concave, slightly keeled in center, or unkeeled; mouth margin not produced; antennæ of moderate size, or third joint enlarged, but never elongate or produced at apex; second joint with at least one dorsal setula; arista bare or pubescent, never plumose; cheeks linear or broadened posteriorly, sometimes one-half as high as eye, bristles confined to margin, vibrissa generally noticeably differentiated; proboscis membranous, not elongated noticeably nor geniculate; palpi normal. Mesonotum with 2-4 pairs of dorso-centrals; mesopleuræ with 1-3 long posterior bristles as well as generally a number of setulæ; one or two bristles above mid coxæ and generally numerous setulæ; propleural bristle strong; squamæ distinct. Ovipositor of female generally with base chitinized, apex seldom protruding; male hypopygium of moderate size, not incurved. Legs without preapical bristle on dorsal surface; end spurs weak. Wings with subcostal vein weak, sometimes incomplete, but generally complete and ending very near to first vein, or fused with first at near apex; costa at end of subcosta uninterrupted, or only slightly so; costal vein with very short hairs which are, with exception of two slightly more distinct at end of subcosta, of almost equal length to beyond middle of wing; cross veins near to wing base, or the outer one at, or slightly beyond, wing middle; posterior basal cell always complete though small; anal vein (sixth) distinct; costa to third vein, slightly beyond it, or to fourth. This last character is difficult to distinguish sometimes, and is not of sufficient importance to permit of the relegation of those species having costa to only third vein, to a different genus from those with costa to fourth.

Synopsis Table of Species in *Agromyza*.

1. Halteres white, or pale yellow; (*maculosa* has a black spot on outer side). . . . . 2
- Halteres black or brown, never pale yellow. . . . . 40
2. Species with the disk of scutellum entirely or partly pale yellow. . . . . 3
- Species with disk of scutellum colored as mesonotum, and never in part pale yellow. . . . . 11
3. At least the apical joint of antennae black. . . . . 4
- Antennae entirely yellow, or third joint only slightly infuscated. . . . . 5
4. Frons black, only the frontal lunule yellow. . . . . 1. *xanthophora* Seidner.
- Frons yellow, only the ocellar triangle black, and sometimes the posterior part of orbits darkened. . . . . 2. *longispinosa*, new species.
5. No short setulae on disk of mesonotum between the dorso-central bristles. . . . . 6
6. Mesonotum with the disk broadly black, only the lateral margin broadly, and the anterior and posterior margins yellow. . . . . 7
- Mesonotum with black, stripe-like marks, or disk black, the center of disk in front of scutellum yellow, owing to the abbreviation of central stripes. . . . . 8
7. Third antennal joint and palpi, at apices, infuscated. . . . . 2a. *variata*, new species.
- Third antennal joint and palpi entirely yellow. . . . . 7a
- 7a. Mesonotum bare except for the dorso-central bristles. . . . . 3 *disalis*, new species.
- Mesonotum with discal setulae in addition to dorso-centrals. . . . . 7b
- 7b. Smaller species, 1-1.75 mm., last section of fifth vein  $2\frac{1}{2}$  to 3 times as long as the penultimate section. . . . . 4 *pusilla* Meigen.
- Larger species, 2-2.5 mm., last section of fifth vein  $1\frac{1}{2}$  to 2 times as long as penultimate section. . . . . 5 *scutellata* Fallen.
8. Only the margins of the discal marks on mesonotum black, the center portions reddish brown. . . . . 8 *melampyga* var. *marginalis*, new variety.
- Markings on mesonotum unicolorous throughout. . . . . 9
9. Markings on mesonotum dull gray black, not glossy. . . . . 6 *borealis*, new species.
- Markings on mesonotum glossy black. . . . . 10
10. Checks, posteriorly, about one-half the eye height; arista almost bare. . . . . 7 *flaviventra* Coquillett.
- Checks, posteriorly, much less than one-half the eye height; arista pubescent. . . . . 8 *melampyga* Loew.
11. Costa reaching to third vein or slightly beyond. . . . . 12
- Costa reaching to fourth vein. . . . . 17
12. Frons lemon yellow; cross veins very close together. . . . . 13
- Frons reddish or black, never pale yellow. . . . . 14
13. Lateral margins of mesonotum broadly pale yellow; anterior two pairs of dorso-centrals on mesonotum much weaker than the posterior two pairs; the front pair not anterior to suture. . . . . 9. *brevicaulis* new species.
- Lateral margins of mesonotum colored as disk; anterior two pairs of dorso-centrals not much reduced in size, the front pair distinctly anterior to suture. . . . . 10 *disalis* Wiedemann.
14. Frons black; cross veins not close together. . . . . 15
- Frons reddish; cross veins close together. . . . . 16
15. Pubescence on arista indistinct; occiput not projecting much on upper half. . . . . 11 *abbreviata* new species.
- Pubescence on arista distinct; occiput distinctly projecting on upper half. . . . . 12 *lineata* new species.
16. Slender, slightly shining, black species; mesonotum with four pairs of dorso-central bristles. . . . . 13 *particella* Coquillett.
- Robust, glossy black species; mesonotum with two pairs of dorso-central bristles. . . . . 11 *nitida*, new species.
17. Frons entirely yellow, or at least the center stripe mostly yellow or reddish, or the orbits yellow posteriorly. . . . . 18
- Frons entirely black or brown, never yellow on any part; frontal lunule sometimes white dusted. . . . . 27

18. Mesonotum opaque gray; center of disk between the rows of dorso-central bristles with a yellowish-brown, longitudinal vitta, which extends to the disk of scutellum; three pairs of orbital, and four pair of dorso-central bristles present.....15 *immaculata* Coquillett  
Mesonotum shining, or, if opaque grayish there is no indication of a central brown vitta.....19
19. Antennæ entirely yellow, or third joint only darkened at insertion of arista.....20  
Antennæ with at least the third joint black, or dark brown, never yellow.....25
20. Head, including antennæ, clear lemon yellow, only ocellar region, frons posteriorly, and back of head black, or brown; pleuræ and legs brown yellow with black or brown marks; lateral margins of mesonotum brown.....16 *citrefrons*, new species  
Frons and face mostly, or entirely, reddish yellow; lateral margins of mesonotum pale yellow, or black and concolorous with disk of mesonotum.....21
21. Five equally strong orbital bristles present; frons one-half as broad as head; orbits not differentiated from center stripe; mesonotum with four pair of dorso-centrals.....17 *pruinosa* Coquillett  
Four orbital bristles present; orbits differentiated from center stripe.....22
22. Lateral margins of mesonotum pale yellow; wings narrow; outer cross vein before wing middle; last section of fourth vein three times as long as the two preceding sections together.....18 *indecisa*, new species  
Lateral margins of mesonotum not pale yellow; wings broad; outer cross vein at near wing middle; last section of fourth vein twice as long as the two preceding sections together.....19 *varifrons* Coquillett
23. Lateral margins of mesonotum broadly pale yellow.....24  
Lateral margins of mesonotum narrowly, or not at all, yellow, the pale color confined almost entirely to the suture, or to the extreme upper margin of the pleuræ.....25
24. Frons with the center stripe clear yellow; orbits posteriorly, sometimes blackened; legs black, or brown, the knees never distinctly yellow.....20 *platyptera* Thomsen  
Frons with the center stripe more or less blackened; legs with the knees distinctly pale yellow.....21 *coquilletti*, new species
25. Palpi yellow.....22 *longipennis* Loew  
Palpi black.....26
26. Larger species—3-3½ mm.—dull gray-black in color; apices of femora and bases of tibiæ narrowly yellow.....23 *coloradensis*, new species  
Smaller species—1½-2 mm.—shining black in color; apical half of each femur yellow, tibiæ brownish yellow.....24 *marginata* Loew
27. Mesonotum with four, or more, pairs of dorso-central bristles.....25  
Mesonotum with two or three pairs of dorso-central bristles.....26
28. The pair of bristles between the posterior pair of dorso-central almost of equal strength with them; basal two joints of antennæ, legs mostly pleuræ, humeri, and abdomen reddish yellow; outer cross vein beyond wing middle.....25 *canadensis*, new species  
The pair of bristles mentioned above much weaker than posterior dorso-centrals, or absent; much darker species; only sometimes a narrow stripe on pleuræ, knee joints more or less broadly, and posterior margins of abdominal segments narrowly yellow; or entire thorax, abdomen and legs black, cross vein generally at or before wing middle or very slightly beyond it.....26
29. Third antennal joint in male enlarged, subquadrate, thickly covered with short, silky pilosity; in female the third joint is smaller and not so noticeably pilose; frontal lunule distinct, whitish pollinose; center stripe of frons brownish.....26 *laterella* Zetterstedt  
Third antennal joint normal in size in both sexes, and not noticeably pilose.....30

\*Sometimes *longipennis* has the antennæ yellowish, in which case the species *imans* will run down to *indecisa* when a comparison of the descriptions will be necessary.

30. Halteres pale yellow, with a black spot on outer side of knob; dorso-central bristles strong, anterior pairs almost as strong as posterior pairs; last section of fifth vein shorter than penultimate section. .... 27 *maculosa*, new species.  
Halteres without any dark spot on knob. .... 31
31. Outer cross vein at about the length of inner cross vein from that vein; third and fourth veins very distinctly divergent at apices. .... 28 *walloni*, new species.  
Outer cross vein separated by a greater distance than inner cross vein from that vein; third and fourth veins slightly divergent at apices. .... 32
32. Small species, at most 2 mm., base of wing, including basal half of first vein, upper part of pleurae and mesopleural vertical suture narrowly, a small patch below base of wing, squamae, and fringe lemon yellow; general color shining black; outer cross vein below, or at very slightly beyond end of first vein. .... 29 *angulata* Loew.  
Species other than above in color, etc. .... 33
33. Larger species, 3 mm. and over, almost entirely black-brown; lower half of orbits rather closely set with hairs. .... 30 *setosa* Loew.  
Smaller species, about 2 mm., not so uniformly colored; lower half of orbits sparsely haired. .... 34
34. Rather robust species; wings broad; cheeks linear; tibiae and tarsi yellowish. .... 31 *isohala*, new species.  
More slender species; wings narrow; cheeks one-fourth as high posteriorly as height of eyes; tibiae and tarsi barely paler than femora. .... 32 *fragaria*, new species.
35. Species with three distinct pairs of dorso-central bristles. .... 36  
Species with 2 distinct parts of dorso-central bristles. .... 39
36. Glossy black species; base of wing, squamae and small portion of pleurae pale lemon yellow; frons not one-third the width of head; anterior pair of dorso-central bristles strong; arista as long as from its base to anterior ocellus; frontal lunule yellowish, distinctly white pollinose; male with apical segments of abdomen conspicuously pale yellow. .... 33 *posticata* Meigen  
Apex of abdomen in male not yellow; frontal lunule not yellow, not noticeably white pollinose. .... 37
37. Smaller species, less than 2 mm. in length. .... 38  
Larger species, over 2 mm. in length. .... 36 *dubitata*, new species.
38. Last section of fifth vein distinctly shorter than penultimate section. .... 34 *neptis* Loew.  
Last section of fifth vein distinctly longer than penultimate section. .... 35 *inconspicua*, new species.
39. Abdomen black, without any metallic sheen; antennae brownish; arista distinctly pubescent. .... 37 *puricornis* Loew.  
Abdomen black, with a metallic, bluish, or greenish sheen; antennae black; arista never distinctly pubescent. .... 38 *viridula* Coquillett.
40. Costa to end of third vein. .... 41  
Costa to end of fourth vein. .... 43
41. Arista short, not more than three times as long as breadth of third antennal joint, distinctly pubescent; outer cross vein at its own length from inner cross vein; three pairs of dorso-central bristles on mesonotum. .... 39 *salicis*, new species.  
Arista bare; mesonotum with two pairs of dorso-centrals. .... 42
42. Cheeks very short, not higher posteriorly than anteriorly, and about one-sixth as high as eye; antennae of moderate size; arista about three times as long as width of third joint. .... 40 *winnemana*, new species.  
Cheeks long, distinctly higher posteriorly than anteriorly, at highest part at least one-third as high as eye; antennae rather small, arista about six times as long as width of third joint. .... 41 *simplex* Loew.

43. Male with anterior angle of cheek produced, the vibrissae formed of a number of bristles, fasciculate, turned upward and generally ending in an anular joint; female with the mouth margin produced anteriorly, but without a fasciculus..... *H. texana*, new species 47
44. Mouth margin not produced anteriorly in either sex; male vibrissae normally formed; large species, over 3 mm. in length; cheeks of almost equal height at anterior and posterior margins; antennae brownish; arista shortly and distinctly swollen at base; palpi almost entirely bare..... *H. vibrissata*, new species 48
- Smaller species, generally less than 2.5 mm. in length; antennae blackish-brown, with elongate swelling; cheeks always higher anteriorly than posteriorly..... *H. affinis*, new species 43
45. Small species, 1.5-2 mm.; frons weakly bristled; discal setulae not carried beyond the transverse line of the posterior pair of dorso-centrals, generally ceasing distinctly in front of that point..... *H. affinis*, new species 43
- Larger species, 2-2.5 mm.; frons strongly bristled; discal setulae carried at least to transverse line of posterior pair of dorso-centrals, generally beyond that point..... *H. affinis*, new species 43
46. Very small species, barely 1.5 mm.; vibrissae in male not very prominent; the anterior angle of cheeks in neither sex much produced..... *H. affinis*, new species 43
- Larger species, about 2 mm.; vibrissae in male prominent; anterior angle of cheek in both sexes very distinctly produced..... *H. texana*, new species 47
47. Species with four distinct pairs of dorso-central bristles on mesonotum; outer cross vein at barely beyond end of first vein; last section of fifth vein twice as long as penultimate section..... *H. abnormalis*, new species 46
- Species with generally only two distinct, rarely three, pairs of dorso-centrals; the outer cross vein at distinctly beyond end of first vein, and the last section of fifth never twice as long as penultimate section..... *H. abnormalis*, new species 46
48. Eyes bare..... *H. affinis*, new species 43
- Eyes with very distinct pubescence on the upper surface close to front of orbits..... *H. circens* Loew 47
49. Fore tibia with a distinct bristle on the posterior surface at about middle third..... *H. affinis*, new species 43
- Fore tibia without any distinct bristle at that point..... *H. affinis*, new species 43
50. Thorax blue, abdomen bronzy-black; orbits with sparse pubescence; bristles situated at nearer to the eye margin than to the inner margin; squamae white, fringe concolorous..... *H. carulea*, new species 48
- Thorax black; abdomen bronzy; orbits thickly pubescent, the bristles situated on nearer to the inner margin than to the eye margin; squamae grayish, margin and fringe brown..... *H. burgessi*, new species 49
51. Arista with very long pubescence, much longer than basal diameter of arista..... *H. plumisea*, new species 50
- Arista with shorter pubescence, or entirely bare..... *H. affinis*, new species 43
52. Mesonotum with three distinct pairs of dorso-centrals; large species, 3.5-4 mm. Larva living in galls on wistaria twigs..... *H. websteri*, new species 51
- Mesonotum with only two distinct pairs of dorso-centrals; smaller species, not near 4 mm., generally 2.5 to 3 mm..... *H. affinis*, new species 43
53. Squamae grayish or brownish, margin and fringe always brown or blackish..... *H. affinis*, new species 43
- Squamae whitish or yellowish, fringe concolorous..... *H. circens* Loew 47
54. Arista distinctly pubescent, and almost as long as from its base to vertex..... *H. longisetula*, new species 52
- Arista much shorter, less distinctly pubescent..... *H. affinis*, new species 43
55. Large species, 2-3 mm.; outer cross vein at less than its own length from inner, inner at distinctly beyond middle of discal cell..... *H. affinis*, new species 43
- Smaller species, distinctly less than 2 mm..... *H. affinis*, new species 43
56. Mid tibial bristles distinct; larva in galls on lime trees..... *H. tiliae* Cresson 53
- Mid tibial bristles absent; larva in galls on poplar trees..... *H. schineri* Cresson 54
57. Mouth margin with numerous, rather strong bristles, which form a group though not a fasciculus, at anterior angle..... *H. congregata*, new species 55
- Mouth margin with the bristles as usual, the single vibrissa differentiated..... *H. minima*, new species 56

1. *Agromyza xanthophora* Schiner.Syn: *Agromyza xanthophora* Schiner, Reise d. Novara, Vol. I, 1868, p. 291.*Agromyza picta* Coquillett, Jour. N. Y. Ent. Soc., Vol. X, 1902, p. 188.

Female: Head black; frons opaque, orbits slightly shining, very narrow; ocellar region raised, sub-shining, distance between ocelli less than the distance from either ocellus to eye; lower orbital bristles apiculate, second pair slightly inwardly directed, the upper two pairs backwardly directed, the center pair in vertical row divergent, outer slightly convergent, post-vertical pair divergent. Frontal lunule yellow, with white pollinosity; face brown, sub-opaque, concave, unkeeled; cheeks almost linear, narrowest posteriorly, mouth margin with numerous hairs, and one strong incurved anterior vibrissa; antennae black, third joint of moderate size, rounded, arista thin, slightly thickened at base, longer than the distance from its base to post vertical bristle, thickly covered with pubescence, which is as long as the diameter of arista at base. Proboscis pale yellow; palpi black, slightly thickened. Thorax yellow; disk of mesonotum shining, but not glossy, with a black mark covering all but the margin anterior to the suture, which is sharply indented transversely at suture, subquadrately excised centrally on the posterior margin, does not reach to scutellum, and has a dentiform longitudinal excision in each lateral lobe posteriorly; four pairs of dorso-central bristles present, the anterior two pairs reduced in size, the anterior pair just in front of suture; all black portion of disk with short hairs, yellow portion bare, except for 5-6 scattered hairs present on the central posterior excision. Pleurae with the upper half yellow, lower half black; squamae yellow at base, apically black, the hairs brown; scutellum yellow, disk bare, margin with 4 bristles; postnotum black. Abdomen yellow, third and fourth segments with indications of a central and two lateral dark spots, most distinct on fourth; fifth and sixth segments glossy black; all segments with numerous black hairs which are bristle-like on posterior margins and most noticeable on fifth. Coxae and legs entirely shining black; the tibia with the usual two posterior bristles. Wings slightly infuscated on anterior half; subcostal vein only indistinct at apex, costa from humeral vein to end of first vein about two-thirds as long as next costal division; second, third and fourth veins slightly divergent; outer cross vein as long as penultimate section of fourth, which is distinctly shorter than the preceding section of fourth; penultimate section of fifth slightly longer than last section. Halteres pale yellow.

Length, 3 mm.

Besides the type specimen of *picta* from Frontero, Tabasco, Mexico (C. H. T. Townsend), there is in the U. S. National Museum collection one female from Las Cruces, New Mexico, June, 1893, (T. D. A. Cockerell).

Food-plant unknown.



2. *Agromyza longispinosa*, new species.

Plate XXX, Fig. 22.

Male and Female: Head yellow, ocellar region, back of head, vertex and third joint of antennae black; frons opaque, very pale yellow, parallel-sided, distinctly broader than the eye; bristles as in *xanthophora*. Third joint of antennae black, sharply contrasting with the pale yellow basal joints, regularly rounded and of moderate size; arista black-brown, swelling at base of terminal section elongate, almost as long as length of third antennal joint, pubescence very short, pale; face almost perpendicular, mouth margin not produced, cheeks distinctly higher posteriorly than anteriorly, at highest part about one-third as high as greatest eye-height, the row of bristles on mouth margin not very strong, black, the vibrissa of moderate strength; proboscis and palpi yellow; the latter slightly the darker, and weakly bristled. Mesonotum yellow, with opaque black-gray mark somewhat similar in outline to that of *xanthophora* but reaching more nearly to scutellum and more elongate owing to the species being less robust than *xanthophora*; the male shows some indication of a pale, linear stripe carried forward from the central posterior excision at either anterior angle, which may in some cases be so distinct as to cause the disk to present a trivittate appearance. Four pairs of very long dorso-central bristles present, the anterior two pairs but little reduced, the anterior pair distinctly anterior to the suture, and the second pair but little posterior to it; between the dorso-centrals there are two slightly irregular rows of setulae, which are exceptionally long for this genus, and which are carried back as far as the prescutellar pair of dorso-centrals; humeri yellow, with a black spot; pleurae yellow with a brownish spot above and slightly behind fore coxae, another large one covering the space between the fore and mid coxae, and another one between the mid and hind coxae, squamae with narrow black border, and brown fringe; scutellum yellow, bare on disk, the four marginal bristles very long; postnotum glossy black. Abdomen yellow, with apical segments darkened or with bases of all segments brownish; base of ovipositor in female glossy black; hypopygium in male glossy brownish black, of moderate size; all segments with black hairs much as in *xanthophora*. Legs yellow, tarsi brownish. Wings clear, veins 2-3 divergent, 3-4 almost parallel on last fourth; second portion of costa about two and one-half times as long as first; outer cross vein a little shorter than section of fourth vein anterior to it; first and second sections of fourth vein subequal; penultimate section of fifth vein distinctly shorter than ultimate.

Halteres yellow. Length, 1.5 mm.

Type.—Cat. No. 15558, U. S. N. M.

Locality: Male: Bear Lake, British Columbia, July 20, 1903, (R. P. Currie).

Paratypes: Female—Kaslo, British Columbia, July 18, 1903, (R. P. Currie); female, same locality, July 7, 1906, (A. N. Caudell), and one one male ex. collection, Wm. Br. Cade, without locality, but presumably Canadian.

Food-plant unknown.

2a. *Agromyza variata*, new species.

Plate XXIX, Fig. 14.

Female: Frons lemon yellow, slightly over one-third the width of head; ocellar region black; orbits darkened on outer edge on upper half; five orbital bristles present; the anterior three closely placed and decreasing much in size to front one, which is very weak; an irregular row of weak hairs on orbits, laterally, beyond the bristles; antennae of moderate size; yellow, third joint infuscated on apical half; arista brown, base swollen, pubescence very short; length of arista equal to a little more than twice the length of antenna; face and cheeks pale yellow; height of cheek posteriorly distinctly higher than anteriorly, at highest point less than one-fourth the height of eye, marginal bristles of moderate length, the vibrissa differentiated; proboscis yellow; palpi yellow, blackened and slightly dilated apically, occiput not visible on upper half. Mesonotum glossy black on disk, lateral margins and a large patch on center of posterior margin, which is rounded in front, pale lemon yellow; four pairs of dorso-centrals present, the disk except on the yellow parts covered with short black setulae; pleurae shining black, yellow along sutures and below wing base; squamae yellow, darkened on margins, fringe brown; scutellum pale yellow on disk, a black spot on each side at base. Abdomen glossy black, posterior margins of segments narrowly yellow. Legs yellow, bases of coxae, tibiae except bases, and tarsi black; no bristles on posterior surface of mid tibia. Wings clear; inner cross vein at below end of first vein and at middle of discal cell; last section of fifth vein twice as long as penultimate section.

Halteres yellow.

Length, 1.5 mm.

Type: In collection C. W. Johnson.

Locality: Calais, Maine.

Food-plant unknown.

3. *Agromyza discalis*, new species.

Plate XXX, Fig. 21.

Female: Frons yellow, opaque, almost parallel-sided, except at near posterior margin, where the sides very abruptly diverge, in breadth it occupies less than one-third the width of head; orbits very narrow; four orbital bristles present; nearer to eye margin on orbit is an irregular row of very short hairs; ocellar region and back of head black; antennae clear yellow, of less than average size; second joint with short dorsal bristle; third joint small, not longer than broad, rounded; arista black, yellowish for a short space at just beyond the rather distinct basal swelling; pubescence indistinguishable; length of arista equal to from the base to second uppermost orbital bristle, face yellow, perpendicular; cheeks yellow, twice as high at posterior margin as at anterior, and at highest part rather more than one-third as high as eye; marginal bristles weak; vibrissa moderately strong; proboscis brownish yellow;

palpi pale yellow, of normal size, bare. Mesonotum shining black on disk, finely granulose; lateral margins broadly pale yellow; humeri brown; four pairs of dorso-central bristles present, the posterior pair more widely separated and stronger than the others; in addition there is in the type an additional pair of bristles, slightly anterior to the fourth pair, which may be abnormal; no setulae present between dorso-centrals on any part of disk; pleurae glossy black, sutures narrowly yellow; squamae pale yellow, fringe concolorous; scutellum pale yellow on disk, broadly black on sides; normal bristles four, but the type has an adventitious bristle close to base of posterior one on left side; pronotum glossy black. Abdomen glossy black; a narrow posterior marginal band on all segments, and a narrow longitudinal dorsal line on last three segments yellow; base of ovipositor glossy black; all segments with dorsal hairs, those on apex of sixth segment bristle-like. Legs yellow; blackened more or less on mid and hind coxae; bases of femora; apices of tibiae, and all tarsi; mid tibia without posterior bristles. Wings clear; first costal division one-half as long as second; subcostal vein distinct, outer cross vein at slightly before the end of first vein, and at about its own length from inner cross vein; last section of fifth vein four times as long as penultimate section; veins 2-3-4 gradually divergent on their last sections, the cells enclosed by these veins of equal width at below apex of second vein. Halteres yellow.

Length, 1.5 mm.

Type: Cat. No. 15559, U. S. N. M.

Locality: Adamana, Arizona, May 7, 1903 (H. S. Barber, one female).

This species is so evidently distinct from those of the *pusilla* group that I consider it safe to describe it from a single specimen.

Food-plant unknown.

#### 4. *Agromyza pusilla* Meigen.

Syn: *Agromyza pusilla* Meigen, Syst. Besch., Vol. 6, 1830, p. 185, species 60.

*Agromyza pusilla* Meigen, l. c. p. 185, species 62.

*Agromyza strigata* Meigen, l. c. p. 186, species 63.

*Agromyza exilis* Meigen, l. c. p. 186, species 64.

*Agromyza orbona* Meigen, l. c. p. 186, species 65.

*Agromyza fusio* Meigen, l. c. p. 187, species 66.

*Agromyza puella* Meigen, l. c. p. 187, species 67.

*Agromyza amoena* Meigen, l. c. p. 187, species 68.

(?) *Agromyza blanda* Meigen, l. c. p. 188, species 69.

(?) *Phytomyza diminuta* Walker, Trans. Ent. Soc. Lond., n. ser. 4, 1857, p. 232.

*Oscinis trifolii* Burgess, Dept. Agric. Rept. 1879, p. 201.

*Oscinis brassicae* Riley, Dept. Agric. Rept. 1884, p. 322.

The above synonymy is I am confident correct, as an examination of a large number of specimens from widely separated localities, including Europe, and many states in the Union, reared from different food plants proves that all the

minor differences used by Meigen for the separation of his species may be found in the same species. *Agromyza blanda* Meigen may be a different species as also may *A. annulipes* Meigen, species 61 of the series quoted in synonymy, but they may only be color varieties. The number of examples in existence representing Meigen's types of this group are as follows: *pusilla*, 1, (Paris); *annulipes*, 1, (Paris); *pumila*, 1, (Vienna); *exilis*, 1, (Paris); *pusio*, 1, (Paris); 2, (Vienna); *obsoleta*, 1, (Vienna); *puella*, 1 defective specimen, (Vienna); *graciosa*, 1, (Paris); *blanda*, 1, (Paris).

Male and Female: Black, shining. Marked in most variable degree with yellow. Frons except ocellar region, and sometimes a narrow side stripe posteriorly, yellow; remainder of head parts except hind vertex, yellow. Mesonotum with a more or less broad yellow margin, which never extends distinctly round the anterior nor posterior margin; four pairs of dorso-central bristles present as well as numerous short hairs on disk; humeri with a black spot. Pleurae with sometimes not much as in *xanthophora* and at other times almost entirely black, with the sutures and upper margin yellow; scutellum entirely yellow, or yellow with black basal side spots, which in some cases extend almost round the entire margin and on to the disk; postnotum black. Abdomen yellowish with dark brownish bases to segments, black with black apices to segments, or entirely shining black with the apical segment whitish, or yellowish, at apex. Legs almost entirely yellow, the tarsi only brownish, to legs almost entirely black with knee joints yellow. The femora generally less intensely black than other parts of legs. Mid tibiae without distinct posterior bristles. Wings clear; second division of costa about two and one-half times as long as first section, third and fourth veins divergent at extremities; outer cross vein as long as or slightly shorter than the section of fourth anterior to it, basal two sections of fourth subequal or the second slightly the shorter; length of fifth vein about three times as long as preceding section.

Halteres yellow.

Length, 1-1.75 mm.

This is a most variable species in color and is very widely distributed. The following is a list of states from which it is represented in the material I have examined. (A full list of American localities, with list of food-plants will appear in the economic bulletin, now ready for the press, dealing with this species).

Massachusetts, Connecticut, District of Columbia, Arizona, Wyoming, Texas, Colorado, California, Utah, Kansas, New Mexico, Indiana, Idaho, Florida and Virginia. It is probable that this species occurs all over the United States.

5. *Agromyza scutellata* Fallen.Syn: *Agromyza scutellata* Fallen Dipt. Suec. *Agromyza*. 1823. 7. 3.*Agromyza flavola* var. Fallen, l. c. 6, 11.*Agromyza pictella* Thomson, Fregat. Eugene. Resa, Dipt. 1851. 54, p. 600.

I have compared examples of the European species with those in collection representing *pictella* and am convinced they are identical. I have some slight doubts as to its specific distinctness, from the foregoing species, but consider it justifiable to retain it as separate species until I know something of the life history of *scutellata*, which has not been bred in this country.

Male and female: Similar in coloration to *pusilla* Meigen, except that the femora are generally the most intensely black portions of the legs and in no examples that I have seen is there any appearance of their being inclined to yellow, especially at base. In size this species is also larger and the wing venation is different. Otherwise, in bristling, etc., the species are identical.

The only American examples I have seen of *scutellata* are five from mountains near Claremont, California (C. F. Baker) and one from Williams, Arizona (H. S. Barber).

6. *Agromyza borealis* new species.

Plate XXIX, Fig. 10, Plate XXX, Fig. 23.

Female: This species is very close to *longispinosa*, but differs in being more robust, in having the frons reddish yellow, instead of pale yellow; the antennæ are reddish yellow; the arista is black, tapering from base to near middle, bare, and distinctly shorter than from its base to vertex; cheeks more than one-half the eye-height; marginal mouth bristles numerous, vibrissæ hardly differentiated. Mesonotum with the marks dull gray black; the posterior lateral stripes narrow, linear, distinctly separated from the inner lateral lobe; the central excision carried forward at its angles but not sufficiently to separate the inner lateral stripes from the central one on their whole length; four pairs of dorso-central bristles present, the anterior two pairs about two-thirds as large as the posterior pairs; the thorax is distinctly broader than in *longispinosa*, being almost subquadrate, in *longispinosa* it is at least one-third longer than broad; the small bristles between the dorso-centrals are at least four-rowed in *borealis*. The pleuræ and scutellum are bristled and colored as in *longispinosa*, the scutellum having two distinct dark lateral basal spots. Abdomen yellow, basal three segments brownish, next two with a brownish spot on each side, sixth with a central black spot; base of ovipositor glossy black, longer than sixth segment, which is not clognated, bristles as in *melampyga*. Legs yellow, tarsi slightly browned; mid tibiæ as in *longispinosa*, without the posterior bristles. Wings grayish, veins yellowish, except third which

is brown; outer cross vein more than its own length from inner cross vein; first and second sections of fourth vein equal; first portion of fifth vein two-thirds as long as last portion. Halteres yellow. Length, 1.5 mm.

Type: Cat. No. 15560, U. S. N. M.

Much as I dislike the idea of describing a new species from a single specimen, I believe that in this case I am justified in doing so, as the specimen is in good condition and presents some good characters for its separation from *longispinosa* and its allies. (Compare *arcticum* Lundbeck)

#### 7. *Agromyza flavonigra* Coquillett.

Plate XXX, Fig. 27.

Syn. *Agromyza flavonigra* Coquillett, Jour. N. Y. Ent. Soc., Vol. 10, 1902, p. 189.

Female: Head yellow, ocellar region and back of head brownish or blackish; frons distinctly, but not greatly, wider than one-third the head width; almost parallel-sided; the orbital bristles strong, black; antennae rather small, yellow, third joint rounded in front, arista brown, yellow at base, almost bare, and falling just short of reaching to vertex; base distinctly swollen, elongate; cheeks broad, one-third higher posteriorly than anteriorly, and at former place one-half as high as eye-height; marginal bristles of moderate length, vibrissa not strong but distinctly longer than the other marginal bristles; proboscis and palpi yellow; palpi linear, with numerous short, black bristles. Mesonotum marked much as in *melampyga*, but the posterior quadrate excavation in center has two linear, yellow, anterior prolongations which divide the black portion more or less distinctly into three vittae; the posterior, longitudinal, yellow, dentiform incision of the outer lobe is also prolonged, and separates the outer portion of the posterior half of the black mark, so that it forms a separate black stripe giving the dorsum the appearance of having five vittae. Four pairs of dorsal central bristles present, the anterior two pairs somewhat reduced in size. In other respects the thorax is much as in *melampyga*, but the fringe of the epinotus is pale and there is a lateral black spot at base on each side of scutellum. Abdomen yellow; first to fourth segments with a dorsal, brown, central spot, fifth with a pair of close placed spots on center of disk, sixth with a pair at near base which are wider placed than those on fourth, and another larger pair more widely placed at about middle; sixth segment about four times as long as fifth; base of ovipositor fleshy black, conical, as long as sixth segment; all segments with numerous black hairs, those on apices of last two segments bristle-like. Legs yellow, brown on base of fore coxae, bases and apices of all femora as well as the entire tibiae and tarsi of all legs. Wings much as in *melampyga*, but the inner cross vein is rather before the end of first vein, the second portion of fourth vein is shorter than first, the outer cross vein rather oblique, and the first section of fifth is shorter than in *melampyga*, being only two-thirds as long as last section. Length, 3 mm.

Locality—Beulah, New Mexico, (T. D. Cockerell). Redescribed from type specimens. Food-plant unknown.

5. *Agromyza melampyga* Loew.

Plate XXX, Fig. 20; Plate XXXI, Fig. 31.

Syn: *Agromyza melampyga* Loew, Dipt. Amer. Sept. Indig. Cent. 8, 1899.*Agromyza sorosis* Williston, Trans. Ent. Soc. London, 1896, p. 129.*Agromyza flaviventris* Johnson, Can. Ent. Vol. 34, 1902, p. 242.

Male and Female: Head yellow, only black behind and on occipital region; frons about one-third the width of head, almost parallel-sided except at just anterior to vertex, where the eyes round off and the frons becomes rather abruptly wider; bristling normal; cheeks narrow, distinctly higher posteriorly, marginal bristles weak, anterior margin incurved, of moderate size; antennae rather below the average, third joint rounded, arista brown, tapering, distinctly but short pubescent, slightly longer than the length of frons from its base to vertex; proboscis and palpi yellow. Thorax colored and marked as in *variegata*; four pairs of dorso-central bristles present; the anterior two pairs much reduced in size; other bristling as in that species; squamae brownish from near base, the apex blackish, fringe brown. Abdomen varying from yellow to brown, with pale apices to segments; all segments with numerous black hairs. Legs generally entirely yellow, sometimes the tibiae and tarsi are darkened somewhat; mid tibiae with two yellow posterior bristles present. Wings clear, or slightly grayish; first costal division about one-half as long as second; second, third and fourth veins divergent on outer third; outer cross vein distinctly shorter than section of fourth vein anterior to it, or almost as long as it, first and second sections of fourth vein subequal, or the former slightly the shorter; penultimate section of fifth vein about three-fourths as long as ultimate section. Halteres yellow.

Length,  $1\frac{1}{2}$ -2 mm.

This species was originally described from District of Columbia, (Osten Sacken) by Loew. Coquillett records it (Bull. 10 in ser. U. S. Dept. Agric. 1898, p. 77) as bred from leaves of a cultivated species of *Philadelphicus*, collected at Washington, D. C. during the latter part of July, 1884, and from mines in leaves of *Plantago major*, collected June 28, 1888, same locality. He states that the larva pupated within the mines. These specimens are in collections at U. S. National Museum. Besides these specimens there is one from Biscayne Bay, Florida, (Mrs. A. T. Slosson) and I have examined a series reared from Plantain, June 26, 1912, Lafayette, Indiana (J. J. Davis).

Johnson described *flaviventris* from Niagara Falls, New York. Williston's species was from St. Vincent, West Indies. Other localities: New Jersey (Smith); White Mountains, New Hampshire (Mrs. A. T. Slosson).

**Agromyza melampyga** var. **marginalis**, new variety.

Male and Female: This variety differs from the type in being rather smaller  $1\frac{1}{4}$  mm.; in being comparatively more strongly bristled, in having only the margins of the thoracic markings black, the remainder being yellowish, and in having the arista shorter, barely reaching to vertex in the only specimen in which it is extant.

The three specimens, two males, one female, were reared from Paspalum, (Oct. 2, 1912). Locality: Columbia, South Carolina, (P. Luginbill) Webster, No. 9711.

Type: Cat. No. 15561, U. S. N. M.

It is possible that this is a distinct species, but the material is too scanty to give one a basis for a definite opinion as to whether it is so, or whether the effect of a different food plant is responsible for the variation in color, etc.

**9. Agromyza brevicostalis**, new species.

Plate XXVIII, Fig. 8.

Female: Frons lemon yellow; one half as broad as head and distinctly broader than long; center stripe blackened on anterior half; orbits differentiated from center stripe; four orbital bristles present; in addition to the bristles there is a row of weak hairs nearer to eye margin, which begins at opposite base of antennae and continues to beyond upper orbital bristle; ocellar region raised, brown; back of head, and a triangular patch at lateral angle of orbits brown, or black-brown; lunule yellow; antennae of moderate size, black brown; second joint with distinct dorsal bristle; third joint rounded in front, covered with short pilosity; arista brown; basal swelling elongate; pubescence very indistinct; length of arista equal to from its base to upper orbital bristle; face yellow, blackened on depressions below antennae; clypeus in profile; keel slight; cheeks yellow, blackened anteriorly; distinctly darker posteriorly than anteriorly; height at highest part less than one-half the height of eye, occiput not projecting on upper half; proboscis yellow; palpi black, normal. Mesonotum gray black, subopaque, broadly pale yellow on lateral margins; a small patch on each side posteriorly, the pale color extending slightly on to anterior lateral angle of scutellum; four pairs of dorso-centrals present, the anterior two pairs reduced in size; no distinct dorso-centrals anterior to suture, beneath the 3 setulae immediately anterior to suture in line with dorso-centrals are rather strong; discal setulae upright, not very numerous; from 1 irregular rows between the dorso-centrals; the pair of bristles between the posterior pair of dorso-centrals distinct, and of moderate length; humeri yellow, with a dark discal mark; pleurae black-gray, shining; sutures and upper margin narrowly, and a patch below base yellow; squamae yellow, fringe brown. Abdomen glossy black, posterior margins of all segments narrowly pale yellow; segments with numerous hairs, stronger on posterior margins; base of ovipositor black, as long as preceding segment. Legs black, glossy, knees



pale yellow, fore tibia and tarsi brownish; mid tibia without posterior bristles. Wings very similar to those of *parvicella*; subcostal vein incomplete; fourth vein not so indistinct as in *parvicella*.

Halteres yellow.

Length, 2 mm.

Type: Cat. No. 15562, U. S. N. M.

Locality: Glacier National Park, Montana, (Hopkins No. 5932c.), one female.

#### 10. *Agromyza davisi* Walton.

Plate XXVIII, Fig. 7.

Syn: *Agromyza davisi* Walton. Ent. News Vol. 1912.

Female: Frons opaque, clear yellow, slightly broader than long, slightly more than one-third as wide as head, ocellar region shining black, orbits blackened posteriorly, back of head black; four pairs of orbital bristles present, the lower pair much the weakest; besides these bristles there is a row of short hairs, nearer to eye margin, almost on the whole length of orbit; antennae above the average size, deep black, third joint subquadrate, covered with very fine short pilosity; arista gradually tapering, almost bare, as long as from its base to vertex; face brown, almost perpendicular, slightly keeled, mouth margin not produced, cheeks opaque, clear yellow, higher posteriorly than anteriorly, but at highest part only about one-fourth as high as eye-height; prebiseis yellow; palpi black. Mesonotum opaque gray, four pairs of dorso-central bristles present, anterior pairs slightly weaker than the posterior two pairs; between the dorso-centrals there are on the anterior half of disk numerous setulae which are irregularly arranged, but which represent at least four rows; anterior pair of dorso-centrals as widely placed as posterior pair; all bristles on margins very long; pleurae shining gray black, the upper margin narrowly yellow, as well as a patch below wing base, and the suture behind middle coxae; squamae pale whitish yellow, fringe concolorous; scutellum concolorous with mesonotum, four marginal bristles present; postnotum shining black. Abdomen brownish black, apices of segments yellowish, ovipositor glossy black, distinctly longer than sixth segment; all abdominal segments with scattered hairs, which are strongest on the posterior margins. Legs black, knees narrowly yellowish; mid tibia without posterior bristles. Wings with costa to slightly beyond third vein, outer cross vein below one-fourth from end of first costal division, and at about one-half its own length from inner cross vein; discal cell shorter than lower basal cell; third and fourth veins regularly divergent on their last sections; fourth vein indistinct from outer cross vein; last section of fifth vein about two times as long as penultimate section.

Halteres yellow.

Length, 2.5 mm.

Type: Cat. No. 15563, U. S. N. M.

Locality: Lafayette, Ind. (J. J. Davis).

A single specimen of this species stood in the U. S. National Museum collection as *Napomyza lateralis* Fallen. Locality: Missouri, reared from *R. abortivus*.

Food-plant: *Ranunculus abortivus*.

11. *Agromyza abbreviata*, new species.

Plate XXXI, Fig. 32.

Male: Frons black; center stripe opaque, brownish in center; glis glossy at base of bristles; five orbital bristles present, the bristles situated on near to inner margin of orbits; beyond them is an irregular row of hairs; ocellar region and ocellar triangle glossy, the latter rather distinctly defined for this group; antennae as in *kincaidi*, but pubescence on arista much shorter; face subshining black, slightly concave in profile; the keel slight; cheeks opaque brown, rather long, distinctly higher at posterior margin than at anterior, at highest part a little more than one-fourth as high as eye; marginal bristles weak, in a double row, and rather numerous; the vibrissa weakly differentiated; eye comparatively larger than in *kincaidi* the occiput less projecting; proboscis yellow; palpi black, normal. Mesonotum shining black; the surface hairs numerous, and rather long; three distinct pairs of dorso-centrals present, the anterior pair reduced, and with a pair of large setulae anterior to them; the pair of bristles between the posterior pair of dorso-centrals distinct, about half as large as the dorso-central pair; plume glossy black, yellowish below wing base; squamae yellowish white, fringe white; scutellum and postnotum glossy black. Abdomen concolorous with thorax; all segments with numerous surface hairs; hypopygium of normal size, glossy black. Legs piebous; knees yellowish, femora black; mid tibia with posterior bristles distinct. Wings clearer and comparatively broader than in *kincaidi*. Halteres yellow, knob white. Length, 3.5 mm.

Type: Cat. No. 15564, U. S. N. M.

Locality: Las Vegas, Hot Springs, New Mexico, (H. S. Barber). One male.

12. *Agromyza kincaidi*, new species.

Plate XXIX, Fig. 12.

Female: Entirely black, except the halteres and squamae, which are white, distinctly shining. Frons shining but not glossy; center stripe opaque, breadth of frons slightly more than one-half of the head width, slightly divergent posteriorly, orbital bristles on near inner margin of orbits, the upper one distinctly lower than anterior ocellus. Bristles close together and decreasing in size as they advance toward the eye. Besides the strong bristles there are smaller hairs arranged in a row nearer to eye margin on the entire length of orbit; frons in profile slightly projecting in front; face concave, with a slight central longitudinal keel, the upper mouth margin slightly protruding; cheeks yellowish, posteriorly almost one-half as high as eye-height, anteriorly less than one-half as high as posterior height; mouth margin

with a double row of bristles, the upper of which are directed forward and slightly upward, and continue to lowest level of eye anteriorly, vibrissa stronger than other bristles, incurved, angled lower than anterior bristles on ridge above; antennae rather short, second joint with short bristles in addition to the dorsal one, and one on under side, third joint rounded except on dorsal surface at apex where it is truncate; arista but little swollen at base, thickly but sparsely pubescent, and shorter than from its base to anterior ocellus; proboscis brownish; palpi black, of moderate size, normal in shape, rather distinctly bristled. Mesonotum with three pairs of dorso-central bristles, and one or two long hairs anterior to the third pair; in addition to these the disk is covered with numerous short hairs. (The large pins used for transfixing the two specimens have practically destroyed the thorax and make it very nearly impossible to judge the nature of the chaetotaxy, and it may be that in some cases the species has four instead of three pairs of dorso-centrals). Scutellum four bristled, disk bare, squamæ whitish, fringe pale. Abdomen glossy black, all segments with numerous hairs, those on apex of sixth segment bristle-like, base of ovipositor glossy black, longer than fifth segment. Legs entirely black, the mid tibiae with the pair of posterior bristles present. Wings grayish, veins brown, costa carried indistinctly beyond third vein, but falling much short of fourth; inner cross vein at end of first vein, outer cross vein at slightly beyond center of wing, and at nearly twice its own length from inner cross vein; second section of fourth vein shorter than first, and rather more than one-fourth as long as last section; last section of fifth three-fifths as long as the preceding section.

Halteres white.

Length, 3 mm.

Type: Cat. No. 15565, U. S. N. M.

Locality: Juneau, Alaska, July 25, 1899, (Kincaid).

The paratype which is in rather poor condition differs slightly from the type in neuration, having the outer sections of the veins comparatively longer than in the type.

The species is named in honor of Prof. Trevor Kincaid, who collected it.

This is the species recorded by Coquillett as *A. neptis* Loew. (Proc. Wash. Acad. Sci. Vol. 2, 1900, p. 463), occurring in Alaska. It is very close to the species described by Schiner (Fauna Austriaca, Vol. 2, 1864, p. 303) as *nigripes* Meigen. He misidentified Meigen's species which has the costa to the fourth vein. Afterwards Rondani placed Schiner's species in *Domomyza* and retained the specific name as *nigripes* Schiner (nec Meigen). This generic division has been repudiated by various writers, and as no other valid name has been given to this species it must be renamed. (See Addenda.)

13. *Agromyza parvicella* Coquillett.

Plate XXVIII, Fig. 4; Plate XXX, Fig. 17.

*Sp. Agromyza parvicella* Coquillett, Jour. N. Y. Ent. Soc., Vol. X, 1902, p. 189.

Female: Black, slightly shining; very slender species. Frons brown, yellowish in front, almost black at vertex, occupying more than one-half the width of the head; orbits distinct, darker than frontal stripe; each orbit rather more than one-half as wide as frontal stripe. Bristles, four on each side from anterior ocellus, situated near outer margin of orbit; the upper two stronger than the lower two, posterior bristles divergent; frons in profile slightly projecting, face slightly concave, mouth margin not projecting, face subshining, black, cheeks yellowish, more than one-half as high as eye, and of almost equal breadth on their entire length, marginal bristles weak, vibrissae black, but not strong; antennae black, second joint with the usual dorsal fringe, which is hair-like, otherwise entirely bare, third joint subapical, of moderate length, falling short of mouth margin, gently rounded at apex, arista thickened at base, very short, barely one and one-third times as long as antennae, thickly, but very shortly pubescent; proboscis yellow at apex, membranous; palpi black, slightly projecting beyond upper mouth margin; occiput swollen from slightly below upper margin of vertex. Mesonotum subshining, four pairs of dorso-central bristles present, the pair anterior to the suture, and the anterior pair behind suture slightly smaller than the posterior pairs; two irregular rows of setulae between the dorso-centrals; pleurae concolorous with disk of mesonotum, but glossy on lower portion; scutellum with four marginal bristles, disk bare; squamae brownish, fringe long, brown. Abdomen concolorous with thorax; first segment elongated, about twice as long as second, remaining segments subequal; last abdominal segment glossy black; all segments with scattered, rather long hairs, those on apex of sixth segment longest. Legs long and slender, brown, trochanters, apices of femora and bases of tibia narrowly yellowish; no bristles present on mid tibiae. Wings brownish, costa reaching only to end of third vein, second costal division two and one-half times as long as first; subcostal vein indistinct, obsolete on apical fifth; outer cross vein slightly before end of first vein, and at about its own length from inner cross vein, second section of fourth vein one-half as long as first; section of fifth vein between cross veins about one-fifth as long as last section; fourth vein indistinct, anal cell distinct, anal vein strong, reaching nearly to wing margin. Halteres yellow.

Length, 2 mm.

Locality: St. Paul Island, Alaska, (Kincaid).

Food-plant unknown.

Redescribed from type specimen in U. S. National Museum collection. This species is rather different from most species of *Agromyza* and may be considered by some writers as belonging to some of the other families in the Acalypterata suborder, but I believe it may be most clearly associated with this genus. Like the next species it belongs to the segregate

of *Agromyza* with the costa to third vein only. This character is not of such importance that it may be considered as of generic value, and I therefore am not using Rondani's generic name *Domomyza*, as species which are very dissimilar are thrown together in *Domomyza*, and thus separated from forms to which they are more closely allied in *Agromyza*.

11. *Agromyza nitida*, new species.

Plate XXVIII, Fig. 1; Plate XXX, Fig. 26.

Female: Frons reddish yellow, distinctly longer than broad, ocellar region black; vertex and orbits posteriorly blackened; upper parts of frons shining, lower and central parts opaque; five pairs of moderately strong orbital bristles present, which are of almost uniform size and situated nearer to inner margin of orbits than to eyes; face slightly keeled, brown, in profile a little concave; antennae brownish yellow, very short, second joint almost bare, the dorsal bristle weak, third joint longer than broad, twice as long as second, regularly rounded at apex; arista brown, slightly thickened at base, almost bare, not as long as half the length of from its base to vertex; cheeks yellow, lower margin narrowly shining black, in outline lower margin rounded, height posteriorly rather less than one-third that of the vertically elongate eye, anteriorly not so high; marginal bristles very weak, vibrissa present but not strong; proboscis yellowish brown; palpi concolorous, small, not dilated, bare. Thorax rounded above; mesonotum about one-third longer than broad, glossy black, covered on the disk with short setaceous hairs, two pairs of rather widely placed, post-sutural, dorso-apical bristles present, the pair of strong hairs between the posterior pair absent; humeri pale yellow, margins of mesonotum brownish; pleura brownish-black, glossy, upper margin narrowly yellow along suture, in front of wing base also yellowish; squamae yellowish, the marginal fringe brown; scutellum rounded, concolorous with mesonotum, four marginal bristles present. Abdomen glossy black-brown, segments with an indication of a linear, yellow, posterior margin; ovipositor glossy black, barely longer than preceding segment; all abdominal segments with scattered hairs, those on the apical segment not much longer than the others. Wings grayish; auxiliary vein complete but indistinct; second costal division about two and one-third times as long as first; outer cross vein situated directly below end of first vein and at its own length from inner cross vein, portion of fourth vein anterior to inner cross vein slightly more than twice as long as reaching beyond it; third and fourth veins regularly divergent on the whole of the last section, latter much less distinct than the longitudinal vein anterior to it; penultimate section of fifth vein one-third as long as ultimate section; costa reaching slightly beyond end of third vein. Halteres with yellow stalk and white knob.

Length, 1.5 mm.

Type: Cat. No. 15566, U. S. N. M.

Locality: Cabin John Bridge, Maryland, April 28, 1912. (Knab and Malloch). Food-plant unknown.

15. *Agromyza immaculata* Coquillett.

Plate XXVIII, Fig. 3.

Syn: *Odinia immaculata* Coquillett, Jour. N. Y. Ent. Soc., Vol. X, 1902, p. 183.

Female: Frons yellow, or reddish yellow, almost parallel-sided, in breadth distinctly, but not greatly, more than one-third the head width; ocellar region black; orbits whitish; entire frons opaque; orbital bristles strong, only three pairs anterior to lower ocellus; the lower pair of which are incurved; face and cheeks pale yellow, the former almost perpendicular and with indistinct keel, the latter distinctly higher posteriorly than anteriorly, at middle less than one-third as high as eye height; marginal mouth bristles distinct, vibrissa not much longer than other bristles; antennae yellow, brownish on upper and outer surfaces, dorsal bristle on second joint distinct, but no other noticeable bristles present; third joint of moderate size, more than twice as long as second, regularly rounded at apex, distinctly longer than broad; arista brown, with almost the basal third swollen, lanceolate, bare, in length as long as from its base to vertex; proboscis and palpi yellow, the latter with 2-3 weak hairs at apex. Mesonotum opaque gray, the space between the dorso-central bristles opaque, yellowish, with the appearance of pollinosity; four pairs of strong dorso-centrals present, which are in parallel rows, and but little weaker anteriorly, two rows of bristles between dorso-centrals, which are regular, equally spaced from dorso-centrals and from each other, and are not continued beyond middle of disk; besides the other normal bristles there are only 3-4 small setulae laterally beyond the dorso-centrals; humeri yellow, with a black spot, lateral margins of mesonotum yellow; pleurae yellow, a longitudinal, elongate spot on middle from propleura over mesopleura, a large triangular spot between fore and mid coxae, a spot above hind coxae, and a less distinct one below wing base; squamae brownish, fringe brown; scutellum concolorous with disk of mesonotum, the yellow central stripe more distinct and, narrowly, much paler, with more the appearance of ground than surface color, in shape the scutellum is subtriangular, flattened on surface; four marginal bristles present; posttergum anteriorly yellow, posteriorly shining black. Abdomen brownish with the posterior margins of basal four segments narrowly, and apex of sixth broadly yellow, or the sixth entirely yellow and the others broadly yellow at apices; ovipositor glossy brown, shorter than sixth segment; all segments with numerous hair-like bristles. Legs yellow, marked with brown on base of fore coxae, upper surface and base of all femora; tibiae and tarsi more or less brownish tinged; mid tibiae without the posterior bristles. Wings grayish on anterior half; subcostal vein indistinct; first costal division one-third as long as second; outer cross vein distinctly beyond end of first vein, and at about twice its own length from inner cross vein, first division of fourth vein shorter than second, first section of fifth vein about three-fourths as long as last section; third and fourth veins subparallel, only distinctly divergent at extreme apices. Halteres pale yellow.

Length, 2 mm.

Type: Cat. No. 6649, U. S. N. M.

Type Locality: Mt. Washington, New Hampshire, (Mrs. A. T. Slosson).

Besides the type there are specimens in collection from the following locations: Two specimens, Santa Fe, New Mexico, (May), (H. S. Barber), one specimen St. Louis, Missouri, April 30, 1904 (W. V. Warner); and one specimen, Kaslo, British Columbia, July 17, 1903, (R. P. Currie).

Food-plant unknown.

The type specimen has the yellow thoracic markings on disk and scutellum rather indistinct, but in other respects is similar. It is a true *Agromyza* and has very little in common with *Odinia ornata* Zetterstedt, which is represented in the U. S. N. M. collection by one specimen from Dauphin county, Pennsylvania.

16. *Agromyza citreifrons*, new species.

Male and Female: Frons opaque, lemon yellow, distinctly longer than broad, one-half as wide as head, parallel-sided; orbits more or less blackened or browned, especially posteriorly; three pairs of long, fine, orbital bristles anterior to front ocellus, the upper distinctly in front of anterior ocellus, anterior to lower bristle there is a weak hair, otherwise the orbits are bare; ocellar region and back of head black; antennae of moderate size, clear lemon yellow; second joint bare except for the weak dorsal bristle; third joint rounded, about three times as long as second; arista concolorous with antennae on the swollen base, brown on remainder, almost bare, barely as long as from its base to anterior ocellus; face yellow, slightly retreating in profile; cheeks concolorous, higher posteriorly than anteriorly, at highest part over one-third the height of eye; eye slightly longer than high; marginal mouth bristles not numerous (1-5) but rather strong, the vibrissa hardly differentiated; proboscis and palpi clear lemon yellow. Mesonotum opaque, brown-black; lateral margins and humeri brownish yellow; four pairs of dorso-central bristles, arranged in parallel rows, anteriorly reduced in length; setulae between dorso-centrals irregularly arranged in 3-4 rows, extending to posterior margin; pleurae lemon yellow, a large brown or blackish triangular spot between the fore and mid coxae, another smaller one over hind coxae and an indistinct longitudinal mark sometimes present on mesopleura on middle; squamae brownish, fringe brown; scutellum brown, with four marginal bristles; postnotum black. Abdomen shining brown, or blackish, lateral margins yellow in female, ovipositor of female glossy brown-black, as long as preceding segment of abdomen; hypopygium of male brownish, organs knob-like, of moderate size; all segments with numerous black hairs, which are noticeably longer on lateral margins and apices of last two segments. Legs yellow, tarsi browned; mid tibia without posterior bristles. Wings clear or slightly

browed; first costal division half as long as second, veins 2-3-4 regularly divergent on last sections, outer cross vein at beyond end of first vein, and at a little more than its own length from inner cross vein or at its own length from it, second section of fourth vein distinctly shorter than first; last section of fifth vein about twice as long as penultimate.

Halteres lemon yellow.

Length, 4-1.5 mm.

Type: Cat. No. 15567, U. S. N. M.

Type locality: Eureka, California, (H. S. Barber). Seven specimens. I have seen one specimen in C. W. Johnson's collection from Princeton, Maine, July 12, 1908.

Food-plant unknown.

17. *Agomyza pruinosa* Coquillett.

Syn: *Agomyza pruinosa* Coquillett, Jour. N. Y. Ent. Soc., Vol. X, 1902, p. 189.

Male: Frons opaque, center stripe reddish, merging into brown on margins and posteriorly, orbits not distinctly differentiated, and, with outer margin of center stripe, blackish; breadth of frons one-half as wide as head; five orbital bristles present, the lower four pairs incurved, the upper one backwardly directed, no distinct orbital hairs present; vertical row and postvertical pair strong; humuli not differentiated from center stripe; face and cheeks reddish yellow, the former concave in profile, keel distinct, and brownish; eye orbits carried back over cheeks, blackish, cheeks and orbits at posterior angle of eye as high as eye, marginal bristles on mouth opening 4-5 in number, strong, upwardly directed, vibrissa hardly stronger, though distinct; proboscis and palpi reddish yellow. Mesonotum grayish black, opaque, elongate, about one-half longer than broad; four pairs of dorso-centrals present, about three irregular rows of setulae between the dorso-centrals; the pair of bristles between posterior pair of dorso-centrals distinct; pleurae subshining, black-brown, paler below wing base; squamae of moderate size, whitish, fringe brown. Abdomen subshining, brownish; hypopygium yellowish brown; of moderate size, all segments strongly haired. Legs strong; reddish yellow, bases of femora, apices of tibiae broadly, and entire tarsi brown; fore femora with distinct, rather long central bristles; mid tibia without any distinct posterior bristles. Wings slightly grayish; first costal division at least one-half as long as second, subcostal vein rather indistinct, complete; inner cross vein at very slightly before end of first vein, outer cross vein slightly outward bent at middle, at almost its own length from inner, and at very little beyond wing middle; veins 2-3-4 distinctly divergent on the outer section; second and third sections of fourth vein together half as long as last section; last two sections of fifth vein subequal. Halteres whitish yellow.

Length, 2.5 mm.

Redescribed from type (Cat. No. 6659, U. S. N. M.).

Locality: Colorado, (H. K. Morrison).

Food-plant unknown.



18. *Agromyza indecisa*, new species.

Female: Frons elongate, fully one and one-third times as long as broad, two-fifths as wide as head; orbits barely darker than central stripe; four equally strong orbital bristles anterior to front ocellus, the upper only slightly lower than anterior ocellus; besides these strong bristles there are several weak hairs situated nearer to eye margin opposite spaces between the bristles; antennae reddish yellow, shaped and bristled as in *citreifrons*, arista entirely brown-black, distinctly swollen at base, almost bare, not reaching to anterior ocellus; face pale yellow, not produced at mouth margin, slightly keeled; cheeks distinctly higher posteriorly than anteriorly, at highest part one-third as high as eye; bristles much as in *citreifrons*; eye as high as long; proboscis and palpi yellow. Mesonotum black, subshining, disk slightly gray pollinose; lateral margins and humeri pale yellow; four pairs of dorso-central bristles present; anterior to the one in front of suture there is a small bristle which may be abnormal; other bristling as in *citreifrons*; pleurae brown-black, shining; sutures yellow, squamae brown; scutellum concolorous with disk of mesonotum, four bristled; postnotum shining black. Abdomen subopaque, brown-black; segments narrowly bordered posteriorly with yellow; ovipositor with base as long as sixth segment; bristles as in *citreifrons*. Legs yellowish brown; fore coxae, with ventral surfaces and apices of femora yellow; posterior mid tibiae bristles absent. Wings grayish; second costal division short of twice as long as first; subcostal vein rather distinct; outer cross vein beyond end of first vein, and at about its own length from inner cross vein; first section of fourth vein longer than second; last section of fifth twice as long as penultimate section. Halteres yellow.

Length, 4.5 mm.

Type: Cat. No. 15568, U. S. N. M.

Locality: Las Vegas, New Mexico, June, 1901, 11,000 feet level, (T. D. A. Cockerell).

Food-plant unknown.

19. *Agromyza varifrons* Coquillett.

Syn: *Agromyza varifrons* Coquillett, Jour. N. Y. Ent. Soc., Vol. X, 1902, p. 189.

Female: Frons parallel-sided, subopaque, center stripe and orbits clear reddish yellow on lower half, blackened on upper half; orbits differentiated from center stripe, very narrow, each about one-fifth as wide as center stripe; four orbital bristles present, which are slightly reduced in strength from upper to lower bristle; no hairs on orbits besides the bristles; antennae yellow, darkened on third joint at insertion of arista; second joint with dorsal bristle and weak apical hairs; third joint rounded in front, of moderate size, not longer than broad, covered with thick, but very short, white pilosity; arista brown, short, about one and one-third times as long as antenna, and as long as from its base to between upper two orbital bristles; pubescence very short but close; face and cheeks yellow, paler than frons, the latter gradually becoming higher towards

posterior margin, at posterior margin less than one-third the eye height, bristles on margin rather weak, vibrissa well differentiated; proboscis and palpi yellow. Mesonotum glossy black, humeri brownish; two pairs of dorso-central bristles present; disk with numerous short setulae; pleurae glossy black, brownish below wing base, squamae grayish, margin and fringe brown; scutellum and postnotum concolorous with disk of mesonotum. Abdomen glossy black; base of ovipositor distinctly longer than preceding abdominal segment; posterior marginal bristles on last abdominal segment strong. Legs brown, apices of femora and bases of tibiae paler, yellowish, mid tibia without distinctly differentiated posterior bristles. Wings clear, broad; first costal division almost one-half as long as second; inner cross vein beyond end of first vein, outer cross vein at below middle of wing, taking its upper end as below middle of costa, and at less than its own length from inner cross vein; second section of fourth vein less than one-half as long as first, first and second sections of this vein together half as long as last section; veins 2-3-4 divergent, fourth vein at below apex of wing; last two sections of fifth vein subequal. Halteres pale yellow. Length, 2 mm.

Redescribed from type. (Cat. No. 6658, U. S. N. M.).

Locality: Washington, District of Columbia, (collection Coquillett). A male in C. W. Johnson's collection from Pottstown, Pennsylvania, differs from the type in having the frons and antennae paler lemon yellow, the arista slightly longer, and the cheeks distinctly over one-third the height of eye. In other respects similar to the female.

Food-plant unknown.

## 20. *Agromyza platyptera* Thomson.

Syn: *Agromyza platyptera* Thomson, Eugene Rosa, 1851-1853, p. 608.  
*Agromyza coronata* Loew, Dipt. Amer. Sept. Indig. Cent. 8, 1869, p. 162.  
*Agromyza jucunda* v. d. Walp., Tijdschr. v. Entom. Vol. X, 1866, p. 161.  
*Oscinis malva* Burgess, Dept. Agric. Rept. 1879, p. 202.  
*Agromyza lateralis* Williston, Trans. Ent. Soc. Lond. 1896, p. 428.

Male and Female: Frons opaque, lemon yellow; orbits sometimes posteriorly blackened; four pairs of orbital bristles anterior to front ocellus; frons generally over one and one-half times as long as broad, and one-third of the head with; ocellar region and back of head black; face slightly concave in profile, yellow, slightly keeled in center; cheeks yellow, rather short, higher posteriorly than anteriorly, at highest part short of one-third the height of eye; eye higher than long; bristles on mouth margin moderately strong, numerous, upper ones upturned, vibrissa stronger than other bristles; proboscis yellow; palpi black, normal in shape; antennae black; dorsal bristle on second joint weak, third joint short, regularly rounded, higher than long, arista brown-black, swollen at base, very shortly pubescent; not as long as from its base to vertex. Mesonotum shining black; lateral margins, including humeri, broadly pale yellow; two pairs of dorso-centrals present, some-

times a weaker anterior pair visible also; surface of disk with numerous irregularly arranged setulae; pleurae glossy black, with upper margin rather broadly and sutures narrowly yellow; scutellum and postnotum concolorous with disk of mesonotum, the former with four bristles. Abdomen shining, brownish-black, segments sometimes narrowly yellow on posterior margins; last segment elongate; all segments with black hairs. Legs glossy black, only in immature specimens paler on knee; mid tibia with the posterior bristles indistinct. Wings clear; first costal division one-half as long as second; subcostal vein indistinct at apex; outer cross vein at very slightly beyond end of first vein, and at, or nearly at, its own length from inner cross vein, second section of fourth vein about as long as first vein or short of it; veins 2-3-4 divergent, last section of fifth vein about twice as long as penultimate section. Halteres yellow, knob paler.

Length, 2-3 mm.

Originally described from California. Loew's specimens (*coronata*) were from Cuba and Pennsylvania. Van der Wulp obtained his specimens (*jucunda*) from Wisconsin. Burgess described his specimens (*malvae*) reared from *Malva rotundifolia* from District of Columbia; while Williston's specimens, (*lateralis*), came from St. Vincent, West Indies.

I have before me specimens from the following localities: Algonquin, Illinois, (collection Coquillett); Tempe, Arizona. (V. L. Wildermuth), Webster's No. 7286; White Mountains, New Hampshire, (Morrison ?); Los Angeles, California; (Coquillett); District of Columbia, from *Solidago*, (no collector's name); Cabin John, Maryland, (Knab and Malloch); San Rafael, Vera Cruz, (C. H. T. Townsend); Baracoa, Cuba, (Busek); Mayaguez, Porto Rico, (Busek); and 3 specimens without locality, one from aster, one from sunflowers and one from verbena.

One of the two specimens from Cabin John, Maryland (April 28, 1912) is much larger than the average, nearly 4 mm. and has the orbital bristles five in number, as well as the anterior hairs in line with the dorso-centrals much stronger than normal, so that there may be said to be four pairs of dorso-centrals. I consider, however, that it is merely an abnormal specimen and not a distinct species, because in almost every other respect it agrees with the typical specimens.

I have arrived at the decision as to the synonymy of this species from a careful perusal of the various descriptions, and consider that it is correct.

I have examined specimens from C. W. Johnson's collection from the following localities: Wollaston, Woods Holl,

Dedham, Auburndale, Fall River and Chester, Massachusetts; Durham, New Hampshire, Winnipauk, Connecticut; Kingston, Rhode Island, and Riverton, New Jersey, which agree well with the description given. Three specimens from same collection taken in the following localities: Chester and Blue Hills, Massachusetts, and Delaware Water Gap, Pennsylvania (Mrs. A. T. Slosson), differ in size, 3 mm., and in having an anteriorly bidentate, yellow spot, posteriorly on each side of disk, the pale color extending on to scutellum at base on each side. I consider that this is merely a color variety, due possibly to a difference in food-plant, or some other cause which could only be determined by rearing the species.

21. *Agromyza coquilletti*, new species.

Plate XXX, Fig. 28.

Male and Female: Frons lemon yellow, subshining, center stripe blackened, most distinctly on anterior margin where it meets the lunule, which is exceptionally elongated, the black color generally disappears on posterior part of center stripe; ocellar region black; orbits black on posterior angle, each orbit half as wide as center stripe at anterior ocellus, gradually broadened to anterior margin of center stripe where each orbit is almost of equal width with center stripe; four orbital bristles present, situated on middle of orbit, laterally beyond these there is a row of 5-7 short setulae, which does not extend to upper orbital bristle; antennae of moderate size, black, second joint brownish; third joint twice as long as second, upper margin flattened a little and apex rather acute, not regularly rounded; arista brown, thickened at base for about one-fourth the length of arista, nearly bare, and as long as from its base to anterior ocellus; face almost perpendicular, slightly produced at mouth margin, slightly keeled, yellow; cheeks yellow, posteriorly almost one-third the length of eye, anteriorly much less; marginal bristles of moderate size, vibrissa strong; proboscis yellow; palpi black. Mesonotum subshining, black, with grayish pedicelosity; three pairs of distinct dorso-central bristles, the setulae anterior to them stronger than the other discal hairs; lateral margins and humeri pale yellow; the pair of bristles between posterior dorso-centrals weak; pleurae brown-black, shining, upper margin and central, vertical, suture narrowly yellow; squamae and its fringe pale yellow; scutellum and pronotum black, shining; abdomen brown-black, shining; all segments narrowly margined with yellow posteriorly; hypopygium of male yellowish-brown; ovipositor of female glossy black, the base as long as last abdominal segment. Legs glossy black, knees distinctly pale yellow; posterior bristles absent from mid tibia; ventral bristles on fore femur rather long. Wings clear, basal part of veins lemon yellow; subcostal vein indistinct; outer cross vein a little before wing middle and well beyond end of first vein; second section of fourth vein longer

than first and twice as long as outer cross vein; third and fourth veins almost parallel from outer cross vein, only divergent at extreme apices; last section of fifth vein about one-fourth longer than penultimate section. Halteres yellow.

Length, 2 mm.

Type: Female. Cat. No. 15569, U. S. N. M.

Type locality: Fort Collins, Colorado, Webster's No. 6610, (C. N. Ainslie), bred from oats

Paratypes: Tower City, North Dakota, Webster's No. 3047, (G. I. Reeves), swept amongst grass; Fort Collins, Colorado, Webster's No. 6646, reared from *Hordeum jubatum*, July, 1910, (C. N. Ainslie); Buckton, Kansas, Webster's No. 5555; reared from volunteer wheat, June 11, 1909, (C. N. Ainslie); Hawkins, Summit County, Ohio (?), August 16, 1902 (no collector's name); Massachusetts (collection Coquillett). I have also examined specimens from C. W. Johnson's collection from the following localities: Fern Rock, Pennsylvania; Norwich, Vermont, Nantucket, Massachusetts and Hanover, New Hampshire.

This species is named in honor of the late D. W. Coquillett, whose work has done much to facilitate an understanding of the North American Diptera.

## 22. *Agromyza longipennis* Loew.

Syn: *Agromyza longipennis* Loew, Dipt. Amer. Sept. Indig., Cent. 8, 1869, species 90.

Female: Frons pale lemon yellow, incision above lunule slightly darkened; orbits blackened posteriorly; ocellar region black; breadth of frons equal to over one-third the width of head, in outline the sides are almost parallel or a little divergent anteriorly; four pairs of long orbital bristles present, in addition to the bristles there is an irregular row of weak hairs nearer to eye margins, which begins at base of antennae and extends to opposite the anterior ocellus; antennae brownish yellow, darker dorsally, of moderate size; second joint with weak hairs on apical margin, and the usual dorsal bristle of moderate length; third joint rounded, covered with thick, but short, pilosity; arista brownish, swollen at base, very thickly pubescent, the pubescence as long as basal diameter of arista, arista as long as from its base to posterior ocelli; face and cheeks clear lemon yellow, the former slightly concave, and with slight keel; cheeks about twice as high at posterior as at anterior margin, at highest part slightly less than one-third the eye height; eye distinctly higher than long, marginal mouth bristles weak but numerous, vibrissa strong. Mesonotum subshining, black; four pairs of almost equally strong dorso-central bristles present; between which are 4-5 rather irregular rows of setulae, no distinctly differentiated bristles between posterior dorso-centrals; lateral margins of mesonotum

sometimes brownish, pleurae brown-black, subshining; upper margin, central vertical suture, and below base of wing narrowly yellow; scutellum concolorous with mesonotum, four bristled; postnotum brown-black, shining. Abdomen shining brownish or blackish; ovipositor glossy black, base slightly longer than last abdominal segment, covered with numerous short hairs. Legs brownish; fore coxae apices of all femora broadly, and bases of tibiae yellow; the basal two pairs of femora are generally almost black; posterior bristles absent from mid tibiae. Wings elongate, clear or slightly grayish; first costal division one third as long as second; inner cross vein at just below end of first vein or very slightly beyond it; outer cross vein distinctly shorter than section of fourth vein anterior to it, first and second sections of fourth vein subequal; last two sections of fifth vein subequal. Halteres pale yellow. Length, 2.5 to 3 mm.

Originally described from District of Columbia (Osten Sacken).

Represented in collection by two specimens from Mount Washington and Franconia, New Hampshire, (Mrs. A. T. Slosson, collection Coquillett); and two from Algonquin, Ill., (collection Coquillett). Three of the specimens were standing as *A. xanthocephala* Zetterstedt, in collection. This identification may have been given out by Coquillett, though I cannot find any published record of the name. Zetterstedt's species differs from Loew's in having the legs entirely black. *Lophipennis* comes very close *capitata* Zetterstedt as understood in Britain, but I have no specimens for comparison, and as Kertész gives *capitata* as a synonym of *geniculata*, which I have from Holland, and find distinct, I consider it advisable to continue the use of Loew's name, meantime.

Food-plant unknown.

23. *Agromyza coloradensis*, new species.

Male and Female: Frons opaque, ochreous yellow, about one-third longer than broad, sides almost parallel; orbits at humle not one-half as wide as center stripe at same part; five pairs of orbital bristles present, the one nearest antennae weakest; these bristles occupy middle of orbit and laterally beyond them is an irregular row of short hairs, which extends from base of antennae to fifth orbital bristle; sides of orbit and back of head blackened; ocellar region shining black; antennae black; basal joint and apex of second on inner surface yellow; second joint with numerous short hairs on dorsal and ventral surfaces, the dorsal bristle distinct; third joint of moderate size, slightly longer than high, regularly rounded on the upper margin or apex obtusely angled; arista black, slightly thickened at base, the pubescence thick but very short, arista in length reaching to front ocellus; face and cheeks pale yellow, the former concave and very slightly keeled in center; cheeks higher po-

teriorly than anteriorly, at highest part about one-third as high as eye, marginal bristles distinct, 6-7, the anterior pair higher than vibrissa; vibrissa strong; proboscis yellow; palpi black, distinctly bristled. Mesonotum subopaque, gray-black, about one-third longer than broad; lateral margins with indications of brownish color, but not yellow; four pairs of long dorso-central bristles present, which are in parallel rows, the anterior pair distinctly in front of suture; four irregular rows of setulae between the dorso-centrals, which are carried to between posterior pair; no distinctly differentiated bristles between posterior dorso-centrals; pleurae marked as in *longipennis*; squamae yellow, fringe brownish; postnotum and scutellum concolorous with disk of mesonotum. Abdomen elongate, shining black, with grayish pollinosity, only the last segment with distinct, very narrow, yellow posterior margins; ovipositor glossy black, base as long as last abdominal segment, segments with numerous short hairs; hypopygium of male rounded, with two flap-like protruding, downward directed, apical organs. Legs black, shining, knees distinctly, but narrowly, pale yellow; mid tibiae without posterior bristles. Wings grayish, rather elongate, venation almost as in *longipennis*. Halteres yellow.

Length, 3.5 to 4 mm.

Type: (Male); Cat. No. 15570, U. S. N. M.

Locality: Florissant, Colorado, (7,000 feet level) June 21, 1907, (S. A. Rohwer). Five specimens, two males and three females. Taken amongst grass. There is a female from Colorado in C. W. Johnson's collection and a male in same collection from Eastport Maine.

Food-plant unknown.

#### 24. *Agromyza marginata* Loew.

Syn: *Agromyza marginata* Loew, Dipt. Amer. Sept. Indig. Cent. 8, 1869, species 91.

Male and Female: Frons pale lemon yellow, shining, center stripe opaque black, deepest in color at anterior margin above lunule; ocellar triangle distinct, black, margins narrowly yellow; orbits of nearly equal breadth on their entire length, darkened anteriorly, four orbital bristles anterior to front ocellus, these are on middle of orbits, there are no additional hairs present on any of the specimens before me; antennae brown, of rather less than normal size, dorsal bristles on second joint of moderate size; third joint rounded, barely longer than broad; arista brown, slightly swollen and tapering at base, almost bare, reaching from its base to anterior ocellus in female, slightly shorter in male; face brown, concave in profile, the lower margin, at mouth, projecting slightly, center keel indistinct; cheeks yellowish brown, short, gradually deepening from front to back, where they are less than one-fourth the height of the eye; marginal bristles distinct, vibrissa strong; eye distinctly higher than long. Mesonotum slightly longer than broad, glossy black brown; three pairs of dorso-centrals present, the anterior pair weak, disk with numerous distinct

setulae; lateral margins and humeri brown; pleurae glossy brown-black; upper margin and central, vertical, suture narrowly, and a patch below wing base yellow; scutellum distinctly broader than long, concolorous with disk of mesonotum; postnotum concolorous with pleurae; squamae yellow, margin and fringe brown. Abdomen glossy brown, or black-brown, posterior margin of last segment sometimes narrowly yellowish; last abdominal segment almost as long as the three preceding segments, ovipositor elongate, glossy black; male hypopygium knob-like, of moderate size, about one-fourth as long as preceding abdominal segment; surface hairs most numerous on the sides of second segment, and longest on apical segments. Legs yellow; basal half of each femur brown-black, apices of tibiae and all tarsi more or less browned; posterior mid tibial bristles absent. Wings grayish; first costal division one-third as long as second, subcostal vein indistinct, but complete, inner cross vein at just below end of first vein, outer cross vein at distinctly more than its own length from inner and at wing middle; first and second sections of fourth vein subequal; penultimate section of fifth vein slightly shorter than ultimate; outer half of last sections of veins 3-4 almost parallel. Halteres clear yellow.

Length, 1.5 mm.

Originally described from District of Columbia (Osten Sacken).

Represented in collection by three specimens, two females and one male, from Beverly, Massachusetts (Burgess). These specimens bear the dates May 28, 1868; August 28, 1869; and May 24, 1874, respectively.

Food-plant unknown.

25. *Agromyza canadensis*, new species.

Plate XXX, Fig. 19.

Female: Frons opaque, brown, sides subparallel, in breadth one-third the width of head and distinctly longer than broad, orbits slightly differentiated, subshining; orbital bristles five in number, situated near to inner margin of orbits, decreasing in size from back to front; no hairs on orbits in addition to bristles; ocellar region shining, the anterior ocellus separated more widely from posterior ocelli than posterior ocelli from each other; antennae yellowish-red, third joint brown; second joint with strong dorsal bristle, and weaker apical hairs; third joint rather elongate, one-third longer than broad, rounded at tip; arista brown, yellow, and with an elongate swelling at base, pubescence very weak, distinctly shorter than basal diameter of arista, length of arista as long as from its base to between upper two orbital bristles; face in profile perpendicular, yellow, with whitish dusting and distinct keel, a blackish line on each side of keel, cheeks linear, only slightly higher at posterior margin than anteriorly, brown, paler on margins; marginal bristles upturned, of moderate strength; vibrissa strong; the weak bristles are continued upward beyond the level of vibrissa; proboscis yellow; palpi brown, slightly spatulate, with distinct bristles.



Mesonotum shining, brown-black on disk, with gray dusting, humeri and lateral margins reddish yellow; five pairs of dorso-central bristles present, the anterior three pairs reduced in size, only the front pair anterior to suture; the pair of bristles between the posterior dorso-centrals very strong; disk with numerous setulose hairs; pleurae brown, shining, sutures and below wing base yellowish; squamae whitish yellow, fringe concolorous; scutellum and postnotum concolorous with disk of mesonotum. Abdomen reddish yellow; last segment not elongated; base of ovipositor glossy black, slightly longer than preceding abdominal segment; all segments with numerous black bristle-like hairs. Legs yellow, stout; posterior side of mid tibia with two bristles. Wings slightly grayish; costa thickened at end of first vein, first costal division (to near side of first vein) less than one-half as long as next division (from end of swollen junction of first vein with costa); upper end of outer cross vein below a point in costa beyond middle of wing; veins 2-3 distinctly, 3-4 hardly divergent; section of fourth vein beyond inner cross vein one and one-half times as long as outer cross vein, and distinctly longer than preceding section of fourth; inner cross vein below junction of first vein with costa; last section of fifth vein three-fifths as long as penultimate section; basal part of wing veins clear yellow. Halteres yellow, knob whitish.

Length 3 mm.

Type: Cat. No. 15571, U. S. N. M.

Locality: Cottage Beaulieu, Ottawa, Canada, August 14, 1906, (Germain Beaulieu), one female.

Food-plant unknown.

26. *Agromyza laterella* Zetterstedt.

Syn: *Agromyza laterella* Zetterstedt, Ins. Lappon, 1838, p. 788, species 7.

*Agromyza grossicornis* Zetterstedt; Dipt. Scand. Vol. XIV, 1860, p. 6456.

*Agromyza magnicornis* Loew, Dipt. Amer. Sept. Indig., Cent. 8, 1809, species 86.

Male and Female: Frons about one-half as broad as head, center stripe opaque, brownish or blackish, with slight whitish dusting, orbits shining, four or five orbital bristles anterior to front ocellus, beyond these, laterally, is an irregular row of hairs; frontal lunule whitish dusted, very distinct; ocellar region shining black; antennae black; in male large, third joint very variable both in size and shape, either subquadrate, elongated and truncate at apex, or enlarged and rounded at apex, very thickly covered with distinct, pale pilosity; in female the third antennal joint is much smaller and rounded; arista black, inserted near base of third joint, thickened on basal third, pubescence very short and indistinct, length of arista equal to from its base to second uppermost orbital bristle; head of male slightly produced in front, the frons slightly buccate; face concave; cheeks short, distinctly higher posteriorly than anteriorly, but at highest part not one-fourth as high as eye, marginal bristles distinct; vibrissa well differentiated; proboscis yellow; palpi black, normal; occiput unprojecting on upper half. Mesonotum black, slightly shining, indistinctly gray dusted, lateral margins

brownish yellow; four pairs of dorso-centrals present; discal setulae rather strong; the pair of bristles between the posterior pair of dorso-centrals distinct, but not large; pleurae glossy black, narrowly lemon yellow along upper and medium vertical suture, and broadly below wing base; squamæ almost white, fringe concolorous; scutellum and postnotum gray black. Abdomen glossy black, or black-brown, posterior margins of segments generally narrowly yellow, sometimes the base of abdomen yellow laterally; hypopygium of male small; ovipositor of female glossy black on basal portion. Legs black, or black-brown, knees distinctly pale yellow; mid tibia without distinct bristles on posterior surface, except in one specimen. Wings clear, basal part of thick veins pale yellow; subcostal vein indistinct, but complete; second costal division about  $2\frac{1}{2}$  times as long as first; inner cross vein at just before end of first vein, and at about middle of discal cell; last cell section of fifth vein subequal with penultimate section; veins 3-4 slightly divergent on their last sections. Halteres yellow.

Length 1.5-2.5 mm.

Localities of specimens examined: Algonquin, Illinois, (collection Coquillett); Franconia, New Hampshire, (Mrs. A. T. Slosson); Biscayne Bay, Florida, (Mrs. A. T. Slosson); Rosslyn, Virginia, October, 1903, (E. S. G. Titus); Beverly, Massachusetts, June 1, 1868, (Burgess); another same collector and locality, June 2, 1876; Worcester, Mass., "Gall on Iris" (no collector's name); and South Fork, British Columbia, (R. P. Currie). There are specimens in C. W. Johnson's collection from Chester and Framingham, Massachusetts.

This species has been recorded by Thomson,\* as feeding galls on blue Iris, and, although there is no collector's name on the Worcester specimen mentioned above, it is very probably belongs to the lot reared by him, as Coquillett identified specimens.

This is a very variable species in color, and structure of the antennæ, and one might be easily led into considering some of the forms as distinct species. I am, however, convinced from my acquaintance with the species in Britain, that there is but one species, though it probably feeds upon different food plants, as I have met with it in situations where it could not have fed upon Iris.

\*Psyche, Vol. XIV, 1907, p. 74.

27. *Agromyza maculosa*, new species.

Male and Female: Shining black, frontal lunule silvery white pollinose; legs with tibiae and tarsi sometimes brownish; halteres white with black spot.

Prons very slightly more than one-third the head width; center stripe opaque; orbits glossy, differentiated from center stripe; five (and occasionally six), strong orbital bristles present; frontal lunule distinct, viewed from above and behind shining silvery white; antennae with second joint brownish, dorsal bristle distinct; third joint of moderate size, rounded at apex, covered with very short, brownish pubescence; arista brown, distinctly swollen and tapering at base, pubescence short and close; length of arista equal to from its base to between upper two orbital bristles anterior to ocelli; face shining in center, subopaque on sides, in profile concave; the central keel rounded, not sharp, cheeks rather short, twice as high posteriorly as anteriorly, marginal bristles rather strong though short, slightly upcurved and continued weakly beyond vibrissa; vibrissa strong, well differentiated; proboscis brownish yellow; palpi black, of normal size and shape. Mesonotum with four pairs of strong dorso-centrals which are slightly reduced in size from posterior to anterior pairs; five or six rather irregular rows of setulae between the dorso-centrals, the pair of bristles between the posterior dorso-centrals slightly differentiated from the discal setulae; pleurae below wing base slightly yellowish; squamae of rather large size, white, fringe concolorous. Abdomen rather broad, ovate; all segments with short dorsal hairs, stronger on margins laterally and posteriorly, noticeably longer on posterior margins of last two segments; base of ovipositor barely longer than preceding segment. Legs strong, front femur with distinct ventral bristles; mid tibia with the posterior two bristles distinct. Wings with base slightly yellowish; first vein yellowish to end; subcostal vein weak; first costal division one-half as long as second; inner cross vein at below end of first vein; outer cross vein at slightly beyond middle of wing, and at its own length, or slightly more, from inner cross vein; last section of fifth vein distinctly, but not greatly shorter than penultimate section; veins 2 and 3 distinctly, 3 and 4 slightly divergent. Halteres white, outer surface of knob and most of stalk blackened.

Length, 3-4 mm.

Type: Cat. No. 15641, U. S. N. M.

Type locality: Jamaica, New York, October, 1896. Bred from chrysanthemum leaves. Paratypes from Louisville, Ky., October 27, 1898; 6 specimens bred from chrysanthemum leaves No. 4064; Lafayette, Ind., October 11, 1901, (H. B. Dorner), 5 specimens bred from leaves of aster; Jamaica, New York, 2 specimens from same lot as type; and one specimen without data from Georgia. One specimen in C. W. Johnson's collection from Bermuda, West Indies.

28. *Agromyza waltoni*, new species.

Plate XXVIII, Fig. 6; Plate XXXI, Fig. 36.

Female: Frons black, center stripe opaque, orbits subshining, glossy at base of bristles; breadth of frons slightly more than one-half the head width, and almost subquadrate; orbits slightly differentiated from center stripe, each at broadest part about one-fourth the breadth of center stripe at same part, orbital bristles five in number, on one side at margin of lunule is another smaller bristle which I take to be abnormal; lunule brownish yellow, covered with white pollinosity; ocellar region subopaque; posterior ocelli occupying about one-fifth the width of vertex; antennae black, rather below average size; second joint with apical bristles on outer side, the dorsal bristle distinct; third joint rounded, barely longer than broad, not distinctly pilose; arista black, paler at base, swollen on basal fourth, almost bare, in length reaching almost from its base to upper orbital bristle; face and cheeks black-brown; slightly gray dusted; the former in profile almost perpendicular, center raised slightly, but not sharply keeled; cheeks at posterior margin about one-sixth the eye height, anteriorly becoming linear; marginal bristles strong, anterior two higher than vibrissae; vibrissae strong; proboscis yellow; palpi black, slightly spatulate, bristles weak. Mesonotum black, slightly shining, grayish dusted; four pairs of dorso-centrals present, these are reduced in size anteriorly; the setulae between the dorso-centrals in about 10 irregular rows, the two bristles between posterior dorso-centrals distinct, separated from each other by almost twice the distance between them and the dorso-centrals; pleurae black, shining, sutures brownish; squamae brownish yellow, fringe brown; scutellum and postnotum concolorous with pleurae. Abdomen shining black. Sixth segment elongated; base of ovipositor shorter than preceding segment; all segments with numerous hairs, those on apices of segments, and especially the sixth, bristle-like. Legs black, shining; knees brownish; fore femur with long ventral bristles; the posterior bristles on mid tibia present, but very short in type. Wings yellowish brown at base; subcostal vein complete, rather distinct; second costal division slightly more than twice as long as first; inner cross vein slightly beyond end of first vein, outer at length of inner from that vein, and distinctly before wing middle, veins 2-3-4 very noticeably divergent at apices; penultimate section of fifth distinctly shorter than ultimate section. Halteres yellow, knobs whitish.

Length, 4 mm.

Type: Cat. No. 15572, U. S. N. M.

Locality: Long Lake, Adirondack Mountains, (Horvath).

One female.

Food-plant unknown.

Named in honor of Mr. W. R. Walton of the Bureau of Entomology.

29. *Agromyza angulata* Loew.

Plate XXIX, Fig. 16; Plate XXX, Fig. 18.

Syn: *Agromyza angulata* Loew, Dipt. Amer. Sept. Indig., Cent. 8, 1868, species 87.

Male and Female: Frons deep black, with sometimes a slight indication of paler color very narrowly along the inner margin of orbits; central stripe opaque, orbits shining; breadth of frons distinctly over one-third the head width, of orbits about one-half the width of center stripe; generally 5 orbital bristles present; in addition to the bristles there are numerous short hairs nearer to eye margin, forming an irregular row from opposite insertion of antenna to upper bristle; ocellar region glossy black; antennae black, of moderate size; dorsal bristle on second joint distinct; third joint rounded at apex; arista brown, basal fifth yellowish and swollen, pubescence very short, length of arista equal to from its base to between upper two orbital bristles; face and cheeks black, or black brown, opaque; the former with a slight central keel, and a little produced at mouth margin; cheeks almost linear, very little higher at posterior margin than at anterior; marginal bristles in a double row, of moderate strength; vibrissa well differentiated; proboscis yellow; palpi black, of normal size and shape. Mesonotum glossy black, lateral margins sometimes brownish; four pairs of dorso-centrals present, the posterior pair strong, the others gradually reduced towards anterior pair, which are rather weak and slightly in front of suture; 7-8 irregular rows of short setulae between dorso-centrals; no distinctly differentiated pair of bristles between posterior dorso-centrals; pleurae glossy black, very narrowly lemon yellow along upper margin to humerus, narrowly along vertical mesopleural suture, more broadly at upper angles of that suture and below wing base; postnotum and scutellum colored as disk of mesonotum, squamae whitish yellow, fringe whitish. Abdomen ovate, glossy black, sometimes with the segments very narrowly pale yellow, or brownish; sixth segment elongated; all segments with numerous surface hairs; apical margin of sixth segment with moderately long bristles; hypopygium of male of moderate size, colored as abdomen, base of ovipositor of female glossy black. Legs black, shining; fore knees pale yellow, knees of hind pairs, fore tibiae and tarsi brownish, or yellowish; mid tibia without posterior bristles. Wings clear; bases of thick veins lemon yellow; first costal division one-half as long as second; outer cross vein below, or slightly beyond end of first vein; subcostal vein indistinct; first two sections of fourth vein subequal, or the first slightly the shorter; last section of fifth twice as long as penultimate section; veins 2-3-4 slightly divergent. Halteres pale yellow.

Length 1.5-2 mm.

Originally described from Pennsylvania (Osten Sacken), and since recorded from New Jersey, (Smith Cat.). Represented in U. S. National Museum collection by four specimens from

Lafayette, Indiana, (P. Luginbill) Webster's No. 9700, reared from timothy grass, and two specimens with the No. 6719, July 13, 1895, District of Columbia. There is one specimen in C. W. Johnson's collection from Auburndale, Massachusetts.

30. *Agromyza setosa* Loew.

Syn: *Agromyza setosa* Loew, Dipt. Amer. Sept. Indig., Cent. 8, 1869, species 83.

Male and Female: Frons black or black-brown; center stripe opaque; orbits shining; width of frons equal to slightly over one-third the width of head; orbits about one-half as wide as center stripe; five orbital bristles present, situated nearer to inner than outer margin of orbits; in addition to the bristles there are numerous short hairs present, between the eye margins and the bristles, which are particularly numerous on the lower half of orbit and terminate in an irregular row at about level of upper orbital bristle; ocellar region shining; ocellar triangle slightly indicated, shining; antennæ black, moderately large; second joint slightly over the average size, with numerous hairs, the usual bristle distinct; third joint rounded at apex, barely longer than broad, covered with short brownish pilosity; arista brown, for a short space paler beyond the distinctly thickened base; pubescence short, but distinct, very close; length of arista equal to from its base to the second uppermost orbital bristle; face and cheeks black-brown; the former perpendicular and with a rounded central keel; cheeks increasing in height from anterior to posterior margin, where they are about one-fourth the height of eye; marginal bristles of moderate length, in two rows, and rather numerous, the upper row upwardly directed; vibrissa differentiated; proboscis brown; palpi black, of moderate size, rather numerously bristled; eyes microscopically haired. Mesonotum subshining black; thickly covered with hairs and with four pairs of dorso-central bristles, the anterior pairs much reduced and the front pair not much stronger than the other dorsal hairs; the pair of bristles between the posterior dorso-centrals distinct, and of moderate length; pleuræ concolorous with disk of mesonotum, only brownish below wing base; squamæ brown, fringe concolorous; postnotum and scutellum colored as pleuræ. Abdomen concolorous with thorax; the surface rather thickly covered with hairs; sixth segment with some bristle-like hairs on posterior margin; hypopygium of male almost similar to that of *parvicornis*; ovipositor of female with base thickly covered with hairs. Legs black, tibiae and tarsi black brown; posterior bristles on mid tibiae very weak. Wings grayish, veins brown; first costal division nearly one-half as long as second; subcostal vein indistinct, almost coalescent with first at its apex; costa thickened at end of first vein; inner cross vein at slightly beyond end of first vein or at just below it; outer cross vein at slightly beyond wing middle, and at slightly more than its own length from inner cross vein; last section of fifth vein about one-half as long as penultimate section; veins 3-4 only slightly divergent at apices. Halteres yellow, stalk darkened at base.

Length 3-4 mm.

Originally described from District of Columbia (Osten Sacken). Represented in U. S. National Museum collection by 3 specimens, one from Monroe, Michigan, no other data; one with the number 2464—, and the third with label to the effect that it was reared from wild rice (*Zizania aquatica*) August 8, 1891, District of Columbia, (T. Pergande). The other records given by Coquillett for this species in Bull. No. 10, n. ser. 1898, Dept Agric., Div. Ent. refer to *fragaria* and *maculosa*.

There is a male specimen in the U. S. National Museum collection which represents probably a distinct species, but its condition is not good enough to permit me deciding the question, as the species of the group are all very closely allied.

Locality: San Mateo County, California (C. F. Baker).

31. *Agromyza isolata*, new species.

Female: Frons black-brown; center stripe opaque, orbits shining; breadth of frons a little over one-third the width of head; orbits slightly differentiated from center stripe, and each about one-fourth as wide; four long orbital bristles present, situated about on middle of orbits; the short hairs sparse and in a short irregular row; ocellar region raised, shining; ocellar triangle not distinguishable; antennae black-brown; second joint with numerous short, apical marginal hairs, and the dorsal bristle distinct, third joint slightly longer than broad; the upper extremity less distinctly rounded than the lower, covered with rather distinctive pile, which is brownish in color, and most distinct on dorsal surface at apex; arista brown, the swelling at base short and glossy; pubescence very short; length of arista equal to from its base to upper orbital bristle; face brown-black, perpendicular, almost without a central keel; cheeks nearly linear, brown-black; marginal bristles in two rows of moderate strength; vibrissa distinctly differentiated, the bristles continued above level of vibrissa; eye apparently bare, about one and one-half times as high as long; proboscis yellow; palpi black. Mesonotum black, shining, but not glossy; four pairs of distinct dorso-centrals present, the posterior pair most widely placed and strongest, the anterior pair of moderate strength, distinctly longer than discal setulae, and appreciably in front of suture; about 7 irregular rows of setulae between the rows of dorso-centrals; the pair of bristles between the posterior dorso-centrals as long as anterior dorso-central pair; pleurae black-brown, glossy, narrowly paler along upper margin and sutures, yellowish beneath wing base; squamae yellowish white, margin and fringe brown; postnotum and scutellum concolorous with disk of mesonotum. Abdomen ovate in shape, glossy black, apical segment yellowish brown at apex, base of ovipositor longer than preceding segment; hairs on ovipositor yellowish, on abdomen and thorax brownish. Legs yellowish brown, the femora blackened; all legs with num-

erous hairs, which are yellowish in color; mid tibia with the posterior bristles small. Wings clear; second costal division about two and one-half times as long as first; subcostal vein distinct, evidently coalescent with first at apical fourth; inner cross vein at slightly before end of first vein; outer at slightly beyond wing middle, and at one and one-half times its own length from inner; veins 3-4 slightly divergent at apices; last section of fifth vein rather over two-thirds as long as the penultimate section. Halteres yellow, knob whitish.

Length 2 mm.

Type: Cat. No. 15573, U. S. N. M.

Locality: Eureka California, May, (H. S. Barber).

Food-plant unknown.

32. *Agromyza fragariæ*, new species.

Plate XXVIII, Fig. 5.

Male and Female: Frons dark brown, or black brown; center stripe opaque; orbits subopaque; breadth of frons distinctly over one-third the width of head; orbit one-fourth as broad as center stripe; four orbital bristles present, the hairs on orbits not numerous; ocellar region shining, black, raised, frontal triangle not distinguishable; antennæ black, sometimes with indications of paler color at apex of second joint on inner surface; rather below the average in size; second joint with weak apical hairs, and the dorsal bristle distinct, third joint not longer than broad, rounded in front, and covered with short brownish pile; arista brown, thickened on basal fourth, the pubescence close, but very short; length of arista equal to from its base to slightly beyond second uppermost orbital bristle; face shining black, perpendicular, keel very slight; cheeks pale brown, linear at anterior margin, about one-third as high as eye at posterior margin; marginal bristles in a double row, numerous, of moderate length, extending above level of vibrissa, which is distinctly differentiated; proboscis yellow; palpi black. Mesonotum subopaque, black, with slight indications of grayish dusting; four pairs of dorso-centrals present, which become shorter towards front, the anterior pair slightly in front of suture; 6-7 irregular rows of setulæ between the dorso-centrals; the pair of bristles between the posterior pair of dorso-centrals distinctly differentiated from the discal setulæ, about as long as anterior pair of dorso-centrals; pleurae shining black-brown, the suture yellowish brown; squamae whitish, fringe brownish-yellow; postnotum and scutellum black, subshining, abdomen shining black, subovate in female, elongate in male; covered with hairs, those on posterior margins of segments bristle-like; the dorsal hairs on abdomen and mesonotum are brownish yellow. Legs rather slender, black-brown, tibiae and tarsi paler; posterior mid tibiae bristles minute. Wings elongate, grayish; first costal division one-third as long as second; subcostal vein rather distinct, almost coalescent with first at its apex; inner cross vein at slightly before end of first vein, and at middle of discal cell; outer cross vein at about one and one-half



times its own length from inner and at wing middle; last section of fifth vein about two-thirds as long as penultimate section; veins 3-4 gradually and slightly divergent. Halteres yellow.

Length 1.5-2 mm.

Type: Cat. No. 15574, U. S. N. M.

Locality: Placer County, California, November, mining leaves of strawberry, (A Koebele).

Three specimens.

### 33. *Agromyza posticata* Meigen.

Plate XXXI, Fig. 29.

Syn: *Agromyza posticata* Meigen, Syst. Besch., Vol. VI, 1830, p. 172, species 16.

*Agromyza terminalis* Coquillett, Proc. Acad. Nat. Sci. Phil. 1895, p. 318.

*Agromyza taeniola* Coquillett, Proc. Ent. Soc. Wash., Vol. VI, 1904, p. 191.

Male and Female: Frons black, center stripe opaque, orbits shining, breadth of frons less than one-third the head width; four orbital bristles below anterior ocellus, small hairs on orbits microscopic in male, strongest in female; lunule silvery white pollinose; antennae brown, of normal size; dorsal bristle on second joint distinct, apex of same joint with numerous short hairs, which are most distinct on the under side; third joint rounded, covered with short, pale pilosity; arista brown, pale yellowish on basal elongate swelling, very thickly covered with short pubescence, which is not longer than the basal diameter of arista; arista as long as from its base to beyond upper orbital bristle; eyes microscopically haired, cheeks and face brown; the latter concave in profile, keel slight; cheeks linear at anterior margin, at posterior margin very slightly broadened, marginal bristles, 5-7, of moderate strength; vibrissa strong; proboscis yellow; palpi brownish yellow, normal in size, with weak end bristles. Mesonotum glossy brownish-black, margins and humeri pale brown, with an indication of yellow along suture between margin of disk and pleurae; three distinct pairs of dorso-centrals present, in one specimen an additional bristle is visible on one side anterior to the front pair; 5-6 irregular rows of setulae between dorso-centrals, the pair of bristles between posterior dorso-centrals distinctly differentiated from setulae but much weaker than dorso-centrals; pleurae glossy brown, yellowish along suture and below wing base; scutellum and postnotum concolorous with disk of mesonotum; squamae whitish, fringe white. Abdomen glossy black-brown; apical three segments and hypopygium of male pale yellow, of female posterior margin of sixth segment distinctly pale yellow; apical segments brownish, ovipositor glossy black; last abdominal segment in male slightly elongated; all segments with numerous short black hairs, the apical segments with unusually weak posterior marginal bristles. Legs brown-black, glossy, knee joints paler; mid-tibia with posterior bristles present, in some cases those number three, instead of the normal two. Wings yellow at base; first costal division almost one half as long as second; inner cross-vein at below, or slightly beyond, end of first vein; subcostal vein indistinct, but complete;

outer cross vein at slightly beyond wing middle, and at rather more than its own length from inner cross vein; last section of fifth vein about two-thirds as long as penultimate section; veins 2 and 3 distinctly, 3 and 4 slightly divergent at apices. Halteres yellow, knob whitish.

Length 3-4 mm.

Localities of male specimens in collection: Delaware county, Pennsylvania, July 23, 1893 (collection Coquillett), the type of *terminalis* Coquillett; Franconia, New Hampshire, (Mrs. A. T. Slosson); White Mountains, New Hampshire (Morrison); District of Columbia, June (collection Coquillett); Oswego, New York, July 7, 1897; and Athens, Tennessee, August, (H. S. Barber).

The female has the apical abdominal segments so much less distinctly pale than the male, that it is with difficulty one associates it with that sex. So dissimilar are the sexes that Coquillett in describing *terminalis* failed to associate with the male two females taken at the same time and place.

It was this sex which he recorded\* as *neptis* Loew, from Chicago. There are females in collection from Delaware county, Pennsylvania, Plummers Island, Maryland, August 3, 1912 (J. R. Malloch); Georgia (no other data); and a specimen reared from mine in leaves of Solidago, July 20, 1884, Virginia (T. Pergande). I have also seen a male and female taken by W. L. McAtee, on Plummers Island, Maryland; and specimens in C. W. Johnson's collection from the following localities: Hanover, New Hampshire; Machias, Maine; Eastport, Maine; Chester, Massachusetts; Winnipauk, Connecticut; Danbury, Connecticut, Rowayton, Connecticut; Buttonwoods, Rhode Island; Norwich, Vermont, and Cornish, New Hampshire. The type specimen of *taeniola* Coquillett is a male of this species.

A peculiarity about this species is that after death the eyes are red, whereas in practically all the other species they become brown or black.

#### 34. *Agromyza neptis* Loew.

Syn: *Agromyza neptis* Loew, Dipt. Amer. Sept. Indig., Cent. 8, 1899, species 93.

Male: Frons black, one-third as wide as head; center stripe opaque brown-black; orbits glossy, each orbit about one-third as wide as center stripe; four orbital bristles present, the hairs on orbits in an irregular row between bristles and eye margin; ocellar region raised, glossy black; antennæ black, rather above the average size; second joint

\*Bull. 10, n. ser., 1898, Dept. Agric. p. 78.

with rather weak dorsal bristle, and weak apical marginal hairs; third joint large, distinctly longer than broad, covered with distinct pale pile; arista brown, tapering, distinctly and thickly covered with short pubescence, which is about as long as basal diameter of arista; length of arista equal to three times the length of third antennal joint; face subshining, black, rather long, concave in profile, central keel slight, but sharp; cheek black, almost linear, slightly higher at posterior margin. Marginal bristles weak; vibrissa weakly differentiated, eye distinctly higher than long; proboscis yellow; palpi black, normal. Mesonotum glossy black, thickly covered with rather long setulae, three pairs of dorso-centrals present, the anterior pair weak; the pair of bristles between the posterior dorso-centrals as long as second pair of dorso-centrals; pleurae glossy black, with a slight indication of pale color along upper margin, and distinctly pale below wing base; squamae yellowish white, fringe white; postnotum and scutellum concolorous with mesonotum, the apical pair of bristles on scutellum as strong as basal pair. Abdomen glossy black, similar in shape to that of *parvicornis*. Wings clear; first costal division almost one-half as long as second, inner cross vein at slightly beyond middle of wing and at distinctly more than its own length from inner; last section of fifth vein distinctly shorter than penultimate section. Halteres white.

Length 2 mm.

Originally described from District of Columbia (Osten Sacken). Aldrich gives it as from Nebraska, but probably refers to another record of the species. I have before me only one specimen which is referable to this species.

Locality: Plummers Island, Maryland, August 3, 1912 (J. R. Malloch).

Food-plant unknown.

35. *Agromyza inconspicua*, new species.

Male: Frons slightly over one-third the width of head; black, center stripe opaque, orbits and ocellar region shining; four orbital bristles present, orbits otherwise almost entirely bare; antennae black, brownish at base; third joint small, rounded, not as long as broad, arista slightly swollen and tapering at base, pubescence very short, length of arista equal to from its base to upper orbital bristle; face black, concave in profile, slightly produced at mouth margin; center keel rounded; cheek brownish yellow, twice as high at posterior as at anterior margin, at highest part one-third as high as eye, marginal bristles of moderate strength, vibrissa slightly differentiated; proboscis yellow; palpi black; occiput linear on upper half. Mesonotum shining black, three pairs of dorso-centrals present, the anterior pair weak and anterior to the suture a setula which may, in other specimens, be strong enough to be classed as a dorso-central; disk very sparsely covered with setulae, only three irregular rows between the dorso-centrals; no distinct bristles between the posterior pair of dorso-centrals; pleurae

glossy black, median vertical suture narrowly pale yellow; scutellum sub-opaque, brownish-black; apical pair of scutellar bristles strongest. Abdomen rather narrow; shining black-brown; hypopygium normal in size. Legs black-brown, knees distinctly yellow; tarsi yellowish brown, no distinct bristles on posterior surface of mid tibia. Wings narrow, clear, veins on basal half pale yellow; costa brown, first division about half as long as second; inner cross vein at distinctly anterior to end of first vein and middle of discal cell; outer cross vein at distinctly more than its own length from inner and very slightly before middle of wing; veins 3-4 on last sections almost parallel; last section of fifth vein about one-fourth longer than penultimate section. Halteres yellow, knob whitish.

Length slightly over 1 mm.

Type: Cat. No. 15575, U. S. N. M.

Locality: Fort Collins, Colorado, reared from mine in *Agropyron*, July 28, 1910, (C. N. Ainslie). Webster's No. 6611.

36. *Agromyza dubitata*, new species.

Female: Frons black, center stripe opaque, orbits shining at base of bristles; breadth of frons a little over one-third the width of head, of each orbit about one-half the width of center stripe; four rather weak orbital bristles present, situated on near to inner margin of orbit; the orbital hairs less numerous than in *californiensis*; ocellar region shining black, raised, the ocelli in an equilateral triangle; antennae black, rather smaller than in preceding species, the third joint not so regularly rounded at apex on upper surface; arista similar to *californiensis*, but slightly shorter; face brown-black, opaque, concave in profile; cheeks brown, almost as in preceding species; proboscis yellow; palpi spatulate, with several moderately strong end bristles; occiput narrow on upper half. Mesonotum shining black, bristled as in preceding species, but the pair of bristles between posterior pair of dorso-centrals shorter and more widely placed; pleurae, squamae, postnotum and scutellum as *californiensis*. Abdomen shining black; ovate; last segment with the hind marginal bristles moderately strong. Legs almost entirely black, the knees brownish, or the tibiae and tarsi brown. Halteres yellow, knob paler.

Length 3-4 mm.

Type: Cat. No. 15576, U. S. N. M.

Locality: Beverly, Massachusetts, July 19, 1869, (Burgess). Other localities: Cottage Beaulieu, Ottawa, and Ile de Montreal, Ottawa, Canada, June and July, 1906. Nine specimens.

Food-plant unknown.

37. *Agromyza parvicornis* Loew.

Plate XXIX, Fig. 11; Plate XXXI, Figs. 35, 37.

Syn: *Agromyza parvicornis* Loew. Dipt. Amer. Sept. Indig., Cent. 8, 1869, species 92.

Male and Female: Frons black or black-brown, opaque, orbits slightly shining, black, four orbital bristles present; orbits differentiated from center stripe, bristles situated nearer inner than outer margin of orbits, a few weak hairs in an irregular row laterally beyond them; antennæ brown or brownish black, rather below the normal size; third joint short, rounded in front, thickly covered with soft, short, whitish pilosity; arista brown, generally yellowish near base, except on the short thickened portion which is glossy black; pubescence very close, generally distinct; length of arista equal to from its base to upper orbital bristle; face brown, nearly perpendicular in profile, the central keel slight; cheeks brown, or yellowish brown, very much higher posteriorly than anteriorly, at highest part one-third as high as eye; marginal bristles numerous; vibrissa differentiated, but not very strong; proboscis brown; palpi black, very slightly dilated, weakly bristled. Mesonotum glossy black; disk thickly covered with short setulae; two pairs of dorso-centrals present; the bristles between the posterior pair distinct; pleurae, scutellum and postnotum concolorous with disk of mesonotum, pleural sutures rarely, and beneath wing bases generally yellowish; squamae whitish yellow, fringes brown. Abdomen colored as thorax; hypopygium of male as Fig. 35, Plate XXXI. Legs black, the tibiae and tarsi sometimes paler, brownish yellow, most distinct on knee joints; mid tibia with the posterior bristles distinct. Wings clear, slightly grayish on anterior half; venation as in figure, halteres yellow, the knob whitish.

Length 3-4 mm.

Originally described from District of Columbia, (Osten Sacken). Larva lives in mines in leaves of corn; occurs in the following states: Florida, District of Columbia, Indiana, Vermont, Maine, Massachusetts, Connecticut, New Hampshire, Wisconsin, Alabama, South Carolina, Illinois and Texas. Probably generally distributed throughout the United States. A full list of localities will be given in the bulletin in preparation dealing with the economic importance of this species and several others affecting field and forage crops.

38. *Agromyza viridula* Coquillett.

Syn: *Agromyza viridula* Coquillett, Jour. N. Y. Ent. Soc., Vol. X, 1902, p. 190.

Female: Frons black, center stripe opaque, orbits distinctly differentiated, shining; breadth of head one-third, or slightly over one-third, the head width; each orbit about one-fourth as wide as center stripe; four strong orbital bristles present, and beyond these, laterally, an irregular row of short hairs; lunule white pollinose; ocellar region shining black; antennae of moderate size, second joint with distinct dorsal bristles and very weak apical hairs; third joint rounded, not as long as broad, covered with very short, whitish pile; arista thickened at base, tapering on basal third, bare, as long as from its base to anterior ocellus; face black, opaque, concave in profile, mouth margin slightly produced, keel very slight; cheek linear at anterior margin, at posterior margin about one-sixth as high as eye, marginal bristles moderately strong, increasing in length towards anterior margin; vibrissa differentiated; occiput not visible on upper half; proboscis yellow; palpi black, of moderate size, the bristles distinct. Mesonotum glossy black; the pair of bristles between posterior pair of dorso-centrals well defined; pleurae glossy black, brownish below wing base; squamae whitish, fringe white; bristles on scutellum subequal. Abdomen glossy black, with a distinct brassy sheen, ovate, bristled as in *parvicornis*. Legs shining black; tarsi brownish; mid tibia with posterior pair of bristles distinct. Wings clear, veins black-brown; second costal division  $2\frac{1}{2}$  times as long as first; subcostal vein distinct; fused with first at its apex; inner cross vein at slightly before end of first vein, and distinctly before middle of discal cell; outer cross vein at wing middle, and  $1\frac{1}{2}$  times its own length from inner cross vein; last section of fifth vein little over one half as long as penultimate section, sixth vein distinctly short of wing margin. Halteres with yellow stalk and white knob.

Length 2.5-3 mm.

Redescribed from type specimen (Cat. No. 6660, U. S. N.M.)

Locality: District of Columbia, June, (collection Coquillett). The other specimens in collection are from District of Columbia, July; Maryland, June; Georgia; Beverly, Mass.; June 29, 1876, (Burgess); and three specimens from the West Indies in poor condition that probably belong to this species, Aguadilla, and Mayaguez, Porto Rico, (A. Busck), and St. Domingo, (A. Busck). These specimens are slightly smaller than the type, but have no distinctive characters by which they may be separated. I have also seen one specimen submitted by Prof. Chittenden of the Bureau of Entomology, from Plano, Texas, June, 1907 (E. S. Tucker) No. 561. There are three specimens in Prof. Webster's material labelled "Reared from blotch mine red oak leaf, June 20, 1912." Lafayette, Indiana, (J. J. Davis).

39. *Agromyza salicis*, new species.

Plate XXIX, Fig. 15.

Male: Frons black, center stripe opaque brown-black, orbits and ocellar region shining; width of frons about one-half the head width; each orbit about one-half as broad as center stripe; five distinct orbital bristles present, the hairs between these and the eye margin rather conspicuous and numerous; antennæ black; rather small; third joint rounded, distinctly shorter than broad; arista brown; swollen on basal fourth; pubescence very short, but distinct; length of arista not as long as from its base to second uppermost orbital bristle; face black, subopaque, retreating towards mouth margin; cheek brown-black, distinctly higher at posterior than at anterior margin, at highest point more than one-half as high as eye; marginal bristles of moderate strength; vibrissa hardly differentiated; proboscis yellow; palpi black, of moderate size. Mesonotum shining black; three distinct pairs of dorso-centrals present; the anterior pair distinctly weaker than the other two pairs, and close to suture; the pair of bristles between the posterior pair of dorso-centrals weakly differentiated; pleuræ shining black, brownish along sutures and below wing base; squamæ grayish, fringe dark brown; scutellum and postnotum concolorous with disk of mesonotum, the former with the bristles subequal. Legs black; mid tibia without distinct posterior bristles. Abdomen black-brown, shining, covered with short setulæ; hypopygium glossy black, small. Wings rather narrow; second costal division  $2\frac{1}{2}$  times as long as first; subcostal vein distinct; fused with first at its apex; inner cross vein at about apex of junction of first vein with costa; outer cross vein at distinctly, but not greatly, before wing middle, and at slightly more than its own length from inner cross vein; last section of fifth vein subequal with penultimate section; sixth vein indistinct. Halteres black.

Length 2 mm.

Type: Cat. No. 15577, U. S. N. M.

Locality: Reading, Massachusetts, May 16, 1908. New York State Collection, from Willow, (E. P. Felt). One male.

40. *Agromyza winnemanae*, new species.

Female: Deep black, glossy; abdomen with an indication of metallic bluish sheen. Frons deep black, center stripe opaque; orbits glossy; width of frons slightly more than one-third the head width; each orbit a little less than one-fourth the width of center stripe; four orbital bristles present; an irregular row of weak hairs between eye and orbital bristles; antennæ of moderate size; second joint with distinct dorsal bristle; third joint barely longer than broad, rounded at apex; arista swollen at base, tapering, bare, in length equal to from its base to second uppermost orbital bristle; face brownish black, opaque; almost perpendicular in profile, with slight, rounded keel; cheek very short, almost linear, not over one-eighth as high as eye, marginal

bristles weak; vibrissa distinctly differentiated though not very strong; proboscis brown; palpi black, normal; occiput linear, the eyes very large and occupying nearly the whole side of head. Mesonotum with two pairs of dorso-centrals; disk covered with short setulae; the pair of bristles between the posterior dorso-centrals not differentiated from the other discal setulae; squamae yellowish brown, fringe brown; apical bristles on scutellum weaker than the basal pair. Abdomen with segments covered with short setulae, those on the posterior margins slightly stronger; sixth segment slightly elongated; base of ovipositor not as long as preceding segment. Legs shining black; posterior surface of mid tibia, in type, without any bristles. Wings clear; second costal division a little over twice as long as first; subcostal vein indistinct, coalescent with first at its apex; outer cross vein at distinctly before wing middle, and at its own length from inner; fourth vein rather indistinct from outer cross vein to apex; last section of fifth distinctly, but not greatly, longer than penultimate section; costa not reaching beyond end of third vein. Halteres black.

Length 3 mm.

Type: Cat. No. 15578, U. S. N. M.

Locality: Plummers Island, Maryland, June 27, 1909, (W. L. McAtee), one female.

Food-plant unknown.

#### 41. *Agromyza simplex* Loew.

Syn: *Agromyza simplex* Loew, Dipt. Amer. Sept., Cent. 8, 1869, species 84.

Male and Female: Entirely shining black. Frons occupying distinctly more than one-third the width of head; center stripe opaque; orbits glossy; ocellar region glossy; the frontal triangle distinguishable, but not separated from center stripe by an impressed line; five orbital bristles present, in addition to those there are numerous soft hairs covering the entire surface, laterally, beyond the bristles, and stretching from opposite base of antennae to upper orbital bristle; antennae rather small, second joint with moderately long dorsal bristle; third joint rounded, with very short, whitish pile; arista bare, the base swollen, length of arista equal to from its base to between uppermost two orbital bristles; face slightly keeled, concave in profile, opaque, brown-black; cheeks opaque brown; orbits carried almost to hind margin of eye, shining; height of cheek at anterior margin less than at posterior, where it is about two-fifths as high as eye; marginal bristles rather weak, upturned; vibrissa weakly differentiated; proboscis brown; palpi black, normal. Mesonotum covered with short setulae; two distinct pairs of dorso-centrals present, and in addition to these there are generally 2-3 setulae anterior to them stronger than the discal hairs; squamae black-brown, fringe concolorous; scutellum with the apical two bristles weaker than the basal two. Abdomen broadly ovate in female, somewhat narrower in male; no metallic sheen visible; last abdominal segment in female elongate; apical bristles on segments not conspicuous; base of ovipositor not longer than preceding



Type: Cat. No. 15580, U. S. N. M.

Locality: Glen Echo, Maryland, June 3, 1898 (R. P. Currie). This species comes very close to the European *curvipalpis* Zetterstedt, but the two males of that species in collection (Bonhill, Dumbartonshire, Scotland, May, 1907-1908, J. R. Malloch) have the arista bare, the basal swelling much more pronounced, and elongate; the frons half as broad as width of head; the last section of fifth vein about equal to the penultimate section, and the outer cross vein before wing middle. It may be well to indicate here that the name *curvipalpis* (Dipt. Scand. Vol. 7, 1848, p. 2782, species 44) was given to this species because of a misapprehension on the part of Zetterstedt, who mistook the vibrissæ for a prolongation of the palpi. Schiner in Fauna Austriaca followed him in this respect. The species was afterwards described by Kaltenbach as *bicornis* (Pflanzenf. 1873, p. 330, species 33).

In the collection are three specimens which may be males of *affinis*, but their condition is so poor that I do not consider it desirable to either place their description on record as such, or describe them as belonging to another species.

The localities are, Key West, Florida, January 1 and February 6, 1869, (Hubbard-?) and one from North Carolina, without other data.

Food-plant unknown.

44. *Agromyza insularis*, new species.

Plate XXXI, Fig. 38.

Male and female: Frons black; center stripe opaque, orbits and the weakly defined ocellar triangle shining; breadth of frons in female barely one-third as wide as head, in male slightly wider; each orbit equal to about one-fourth the width of center stripe; four rather weak orbital bristles present; in addition to the bristles there is an irregular row of very short hairs nearer to eye margin; frons in profile decurved, not projecting; antennæ brown-black, small; third joint not as long as broad, rounded in front, distinctly pilose; arista black, basal fifth thickened, tapering, almost bare, length equal to from its base to second uppermost orbital bristle; face black, concave, mouth margin slightly produced; cheek black-brown, narrow, almost linear at posterior margin, distinctly higher anteriorly, but not very much produced; vibrissa in male fasciculate in form, the length not equal to that of cheek, and not very conspicuous; in female the vibrissa is distinct and almost as long as in male, but consisting on only one bristle; marginal cheek bristles much weaker than vibrissa; proboscis brownish

yellow at apex; palpi black, rather short and slightly spatulate, the bristles weak; occiput linear. Mesonotum shining black; two pairs of dorso-centrals present; the discal setulae very sparse behind anterior pair of dorso-centrals, and not carried to level of transverse line of posterior dorso-centrals; pleurae glossy brown or blackish, margin and fringe black-brown; scutellum concolorous with disk of mesonotum, the bristles subequal. Abdomen glossy black; ovate; segments with numerous short setulae, posterior margins with more distinct bristle-like setulae; base of ovipositor glossy black. Legs black. Wings grayish; veins black-brown; second costal division slightly more than twice as long as first; subcostal vein indistinct, coalescent with first at its apex; inner cross vein at below end of first; outer at its own length from inner, and at slightly before wing middle, last section of fifth vein barely longer than penultimate section; veins 3-4 slightly divergent on last sections. Halteres black.

Length barely 1.5 mm.

Type: Cat. No. 15581, U. S. N. M.

Locality: Cayamas, Cuba, December (E. A. Schwarz).  
Male and female, taken in cop.

45. *Agromyza texana*, new species.

Male and Female: This species is very similar to *insularis* in general appearance, but differs as follows: The arista is not so much swollen at base, nor for such a long distance; the cheek is much more distinctly produced in both sexes, and comparatively higher anteriorly; the vibrissa is much more conspicuous in the male, and as long as cheek length, in female the vibrissa is comparatively weak and not nearly so long as in male, consisting of one hair only; the thorax is more densely covered with setulae, which are carried at least to level of transverse line of posterior dorso-centrals; the legs are black in both species and the posterior bristles are absent from mid tibiae; the wings have the outer cross vein at wing middle, or very slightly beyond it, and the last section of fifth vein slightly shorter than penultimate section.

Length 1.5-2 mm.

Type: Cat. No. 15582, U. S. N. M.

Locality: Brownsville, Texas, January 27, 1909 (Mc-Millan and Marsh). reared from Roripa. One male.

Paratypes: Cabin John Bridge, Maryland, April 28, 1912, two females (Knab and Malloch); Brownsville, Texas, January 27, 1909, one female, same data as type; and one female Veitch, Virginia, June 9, 1912 (F. Knab).

46. *Agromyza abnormalis*, new species.

Plate XXIX, Fig. 9.

Female: Frons black-brown; center stripe opaque; orbits black, shining; breadth of frons over one-third that of head; orbits at widest part one-third as wide as center stripe at that part; five strong orbital bristles present, and in the type a weak one anterior to the lower strong one; upper two bristles situated near to inner margin of orbits, the others nearer to center; besides the bristles there are scattered short hairs present on the orbits nearer to eye margin than bristles; ocellar region raised, shining black; ocellar triangle not defined; frons in profile slightly protruding anteriorly; antennae black-brown, of moderate size; dorsal bristle on second joint distinct; third joint rounded in front, slightly longer than broad, pilosity very short; arista rather thick, swollen more distinctly on basal fifth, pubescence short, but distinct; length of arista equal to from its base to upper orbital bristle; face shining black, slightly retreating, mouth margin not produced, center keel very slight; cheek opaque brown, half as high anteriorly as posteriorly, where it is half as high as eye; marginal bristles of moderate length; the vibrissa slightly differentiated; proboscis yellow; palpi black, normal; occiput slightly projecting. Mesonotum black, subshining; four pairs of dorso-centrals present, the anterior pair in front of suture, discal setulae numerous and rather regularly arranged in rows, of which there are about five between the dorso-centrals; no differentiated bristles between posterior pair of dorso-centrals; pleurae shining black, the sutures and below wing base brown; squamae gray-brown, margins black-brown, fringe brown; scutellum concolorous with disk of mesonotum, the bristles subequal. Abdomen black, glossy; segments rather strongly setulose; ovipositor very glossy black. Legs black, tibiae and tarsi brownish; mid tibia without posterior bristles. Wings grayish; first costal division distinctly over one-half as long as second; subcostal vein indistinct, but complete, not fused with first at its apex; inner cross vein distinctly, but not greatly in front of end of first vein, and at or slightly beyond middle of discal cell; outer cross vein at about its own length from inner and very slightly beyond end of first vein; veins 3-4-5 gradually and slightly divergent on their last sections; last section of fifth vein twice as long as penultimate section. Halteres brown.

Length 3 mm.

Type: Cat. No. 15583, U. S. N. M.

Locality: Washington, District of Columbia, June, 1903, No. 9727—"on Aphid"—"On roots of *Amaranthus*."

Paratype: labeled "Twilight" Lawrence, Kansas, (E. S. Tucker).

47. *Agromyza virens* Loew.

Dipt. Amer. Sept. Indig. Cent. 8, 1860, species 84.

Male and Female: Frons black, orbits and ocellar triangle glossy, center stripe opaque; breadth of frons slightly over one-third that of head; breadth of orbits over one-third that of center stripe; five orbital bristles generally present, the orbits densely covered with short, fine, hairs; frons generally slightly buccate; antennae brown-black, of moderate size; third joint rounded; arista slightly swollen at base, very thickly, but shortly pubescent; as long as from its base to upper orbital bristle; face concave in profile, brown-black; cheeks higher at posterior than anterior margin, at highest part about one-fourth as high as eye; marginal bristles of moderate strength; vibrissa differentiated; proboscis brown; palpi black, normal; occiput slightly projecting; eyes generally distinctly and thickly pubescent above. Mesonotum glossy black, with sometimes a bluish or greenish tinge; squamae white, or yellowish, the margin yellowish, fringe pale yellowish, or white. Abdomen glossy black, generally with a metallic tinge, either bluish, greenish, or bronzy; in shape and vestiture as in *tiliae*. Legs as in *tiliae*; the posterior mid tibial bristles distinct. Wings grayish, or almost clear, veins brown; venation almost as in *tiliae*.

Length 1.5-2.5 mm.

Specimens from Lafayette, Indiana (F. M. Webster). Mining in roots of clover. There are five other specimens in collection with Webster's No. 10,073, from Lafayette, Indiana; one from Gladbrook, Iowa, February 14, 1890, (No. 4608) mining in stems of *Ambrosia artimisaefolia* (A. M. Sharp); two from Cambridge, Massachusetts, "mining in stems of a weed" (H. G. Hubbard); one marked 30420, referred to as a Tachinid in notes, from stem of a weed in which some species of Cecidomyid was mining, April 18, 1883 (locality doubtful); two specimens labeled "Parasitic on Cecidomyid on aster with yellow flowers," May 23, 1884 (locality doubtful); two from stems of *Ambrosia*, March, 1895, District of Columbia, one from *Nabulus albus*, May 14, 1883 (locality doubtful); two from California (Alameda and Los Angeles), collection Coquillett; one from Georgia, no other data; one from Flagstaff, Arizona, July, (H. S. Barber). One from Plummers Island and four from Washington, D. C. are in the collection of W. L. McAtee and a series of 13 specimens from the Brodie collection are in the U. S. National Museum collection, locality Toronto, Ontario, Canada.

In some cases, I believe with specimens which have been on the wing, it is not very easy to see the hairs on the eyes, but in freshly emerged examples these are very noticeable on

the upper surface of the eyes close to the orbits. A single specimen from Claremont, California (Baker), may belong to a distinct species.

48. *Agromyza cærulea*, new species.

Plate XXIX, Fig. 13.

Female: Frons black; center stripe opaque brown-black, orbits and ocellar triangle glossy black; width of frons equal to slightly over one-third that of head; each orbit slightly less than one-fourth the breadth of center stripe; four strong orbital bristles present, the orbital pubescence not very conspicuous; frontal triangle fairly well defined, reaching over three-fourths of the way to lunule; lunule shining, brownish, with indications of whitish pollinosity; antennæ small, black; dorsal bristle on second joint long; third joint not longer than broad, rounded at apex, pilosity pale, very short; arista thickened and tapering on basal fourth, pubescence distinct, slightly longer than basal diameter of arista, length of arista equal to from its base to upper orbital bristle; face short, black, concave in profile; cheek short, shining black, marginal bristles very numerous, strong, and irregularly arranged, not in a single row, carried upward beyond the level of the weakly differentiated vibrissæ; proboscis yellow at apex; palpi black, numerous bristled; occiput not produced. Mesonotum glossy blue-black, more inclining to brown-black on lateral margins; two distinct pairs of dorso-centrals present; disk covered with numerous short setulæ; no distinct bristles between the posterior dorso-centrals; pleuræ glossy blue-black, sutures and below wing base brown; squamæ white, fringe concolorous; scutellum concolorous with disk of mesonotum, the marginal bristles subequal. Abdomen ovate, bronzy blue-black; first two segments short, the others subequal, all segments with short discal setulæ, those on posterior margins of segments strong; base of ovipositor not longer than preceding segment. Legs strong, especially the femora, which are thickened; black, shining, tibiae at base brownish; fore tibia with a strong bristle on posterior surface at below middle; the pair of bristles on posterior surface of mid tibia strong. Wings clear, veins brownish yellow; second costal division about twice as long as first; subcostal vein indistinct; outer cross vein at slightly below wing middle, and at a little more than its own length from margin to wing on fifth vein, and from inner cross vein; veins 2-3 divergent, 3-4 slightly convergent at apices; inner cross vein at below junction of first vein with costa, and at middle of discal cell. Halteres black, pedicel yellowish brown. Length 3-4 mm.

Type: Cat. No. 15584, U. S. N. M.

Locality: The specimen bears the M. S. label "S. J. Allende, Mexico," and the numbers 11-29, which probably means that it was taken on November 29. I cannot find on the available maps of Mexico any locality in accordance with that on the label. No collector's name is given. One specimen.

Food-plant unknown.

49. *Agromyza burgessi*, new species.

Plate XXXI, Fig. 34.

Female: Frons black; center stripe brown-black, opaque, orbits glossy black; breadth of frons distinctly, but not greatly, over one-third the width of head; breadth of each orbit about equal to one-fourth the width of center stripe; generally six strong orbital bristles present, in one specimen five only; the bristles situated on nearer to inner than outer margin of orbits; the space between eye margin and bristles thickly covered with short hairs; ocellar triangle poorly defined anteriorly, the gloss on surface not continuing to its apex; lunule whitish pollinose; frons projecting slightly anteriorly, giving the head a somewhat buccate appearance; eye orbit continued to almost hind angle of eye; glossy black; antennæ small, brown; third joint not longer than broad, regularly rounded at apex; arista swollen at base, bare, as long as from its base to between second and third uppermost orbital bristles; cheek brown, distinctly higher at posterior than at anterior margin, and at highest point distinctly over one-third the height of eye; marginal bristles of moderate strength, not numerous; vibrissa well differentiated; proboscis brown; palpi black, slightly spatulate, weakly bristled at apex; occiput distinctly visible on upper half. Mesonotum black, glossy, without any distinct bluish fringe; bristles as in *cerulea*; pleure brown-black, the sutures and below wing base pale brown; squame grayish, margin black-brown, the fringe brown; scutellum black, glossy, bristles subequal. Abdomen glossy black or brown-black, with, in some lights, a bronzy luster; second segment not so distinctly shortened as in *cerulea*; in other respects similar to that species. Legs similar to previous species, but the bristle on fore tibia is weaker. Wings in most respects similar to *cerulea*, but the third and fourth veins are distinctly divergent on their outer sections. Halteres brown.

Length 3.5-4 mm.

Type: Cat. No. 15585, U. S. N. M.

Locality: Beverly, Massachusetts, June 2, 1876 (Burgess).

Specimens of this species are in collection from Tower City, North Dakota, (G. I. Reeves), Webster's No. 3122, 2 females; and Colorado, No. 1563, no collector's name, 1 female. I have named this species in honor of the late Edward Burgess, who collected the type specimen 37 years ago. I have seen one specimen in C. W. Johnson's collection from Lancaster, New York, which has the bristles on fore tibia indistinguishable.

Food-plant unknown.

50. *Agromyza plumiseta*, new species.

Female: Frons black, center stripe opaque, orbits, ocellar region, and the well defined ocellar triangle glossy black; breadth of frons one-third the head width, ocellar triangle reaching three-fourths of the way to lunule, which is whitish pollinose; orbital bristles four in number, moderately strong; hairs on orbits numerous and irregularly arranged; each orbit one-fourth the width of center stripe; the bristles situated close to inner margin; antennae of moderate size, deep black; third joint rounded in front, not as long as broad; second joint with distinct dorsal bristle; arista brown, swollen at base, pubescence very distinct, longer than basal diameter of arista, length of arista equal to from its base to upper orbital bristle; face black, concave; mouth margin slightly produced; cheek very short and low; marginal bristles rather weak, vibrissa well differentiated; proboscis yellow at apex; palpi black, slightly spatulate, and weakly bristled at tips; occiput not projecting. Mesonotum blue-black; two pairs of dorso-centrals present; setulae numerous on disk, continued posteriorly beyond transverse line of posterior dorso-centrals; pleurae black, shining, with a bluish sheen, the sutures, and below wing base brown; squamae yellowish white, fringe concolorous; scutellum colored as disk of mesonotum, apical pair of bristles very slightly smaller than basal pair. Abdomen black, with a distinct, metallic blue sheen; basal segment brown; all segments with very numerous discal setulae, those on apices of segments most distinct; sixth segment very slightly elongated; base of ovipositor not longer than preceding segment. Legs black, shining, strong; posterior surface of mid tibia with the pair of bristles distinct. Wings clear; veins brownish yellow; first costal division barely more than one-third as long as second; inner cross vein at below end of first vein and at middle of discal cell; outer cross vein at very slightly beyond wing middle, and at more than its own length from inner; veins 2-3-4 gradually divergent on their last sections; last section of fifth vein about two-thirds as long as penultimate section. Halteres black.

Length 2 mm.

Type: Cat. No. 15586, U. S. N. M.

Locality: Bayamón, Porto Rico, January, 1899, (A. Busck) Along with the type there is a male from Fajardo, Porto Rico, February, 1899 (A. Busck), which belongs here. It differs only in having the frons slightly less than one-third the head width and though in poor condition is evidently, in other respects, identical with the female.

Food-plant unknown.

51. *Agromyza websteri*, new species.

Male and Female: Frons deep black; center stripe opaque, orbits and ocellar triangle glossy; width of frons almost one-half that of head, narrower at anterior margin than posteriorly; width of each orbit about one-fourth that of center stripe; five orbital bristles generally present, but sometimes there are six in aberrant specimens; besides the bristles, which are situated on close to inner margin of orbit, there is an outer irregular row of short black hairs; antennae of moderate size, black with sometimes whitish pollinosity; second joint with distinct dorsal bristles, and weak apical hairs; third joint rounded, distinctly shorter than broad, pilosity very short, whitish; arista with a distinct, elongate thickening at base, which occupies almost one-third the length of arista; pubescence very indistinct; length of arista equal to from its base to middle of orbit; face opaque black; concave in profile, the mouth margin slightly produced; cheek opaque black; of almost equal height on its entire length, which is equal to about one-fourth the eye height, marginal bristles in a double row, the upper slightly upturned, of moderate length; vibrissa distinctly differentiated; proboscis yellow-brown at apex; palpi black, slightly spatulate, weakly bristled. Mesonotum subshining black, with slight indications of grayish pollinosity, especially on sides; disk very thickly covered with short, upright, black setulae; three pairs of dorso-centrals present, the anterior pair weak, and occasionally there are 2-3 setulae in line with those, which are distinctly longer than the other discal setulae, but which are clearly not macrochaetae; no differentiated bristles between the posterior dorso-centrals; pleurae black, subshining, sutures brownish; squamae brown, or gray, the margin blackish, fringe black-brown; scutellum concolorous with disk of mesonotum. Abdomen shining black; broadly ovate; segments with distinct dorsal setulae, those on posterior margins, and especially on sixth segment, in female, longer; sixth segment slightly elongated; base of ovipositor glossy black; male hypopygium small, shining black. Legs black, shining; femora strong; no bristles distinguishable on mid tibia in any of the specimens before me. Wings grayish; veins brown-black; first costal division distinctly more than one-half as long as second; subcostal vein distinct; fused with first at apex; inner cross vein below end of first vein; outer cross vein not upright, its upper extremity nearer to wing tip than its lower, situated at generally less than its own length from inner cross vein, and its upper extremity just before wing middle; veins 3-4 distinctly divergent at their apices; last section and penultimate section of fifth vein subequal. Halteres black.

Length 3.5-4 mm.

Type: Cat. No. 15587, U. S. N. M.

Locality: Seattle, Washington, issued January 21, 1913, from galls on twigs of pink wistaria from Japan, (F. M. Rhoder). Another specimen from same lot, in poor condition January



19, 1913 from same lot of galls. There are four specimens representing both sexes marked Ex. galls on pink wistaria, Japan, B. B. Whitney, No. 745.

This species has been recorded as *Agromyza schineri* Giraud,\* on the authority of Aldrich. *Schineri* was reared from poplar by Giraud in Europe,† and is a much smaller species. The description of Giraud's species is brief but does not permit of one identifying it with the Japanese species. I include this imported species in my paper because it evidently has every chance of becoming established in this country. One striking peculiarity of the specimens before me of this species is the amount of variation in the number of bristles on head, thorax and scutellum. In many cases the normal bristle is duplicated and the number on any one part is not so consistent as in the other species of *Agromyza*. The distance between the cross veins of the wing is also very variable. In the figure of the wing given in the California publication the costa is carried only to the third vein whereas in all my specimens it is continued to the fourth.

52. *Agromyza longiseta*, new species.

Plate XXXI, Fig. 30.

Female: Frons deep black; center stripe opaque; orbits, and ocellar region shining; ocellar triangle not defined; width of frons barely one-third that of head; orbits ill defined, each one not one-fifth as wide as center stripe; four strong orbital bristles present; only a few short hairs on orbits besides the bristles; frons unprojecting, but head somewhat buccate in profile; antennae rather small, black; third joint regularly rounded in front, about as long as broad, covered with short pilosity; dorsal bristle on second joint distinct; arista very slightly, and shortly, swollen at base, distinctly pubescent, the pubescence as long as diameter of base of arista, length of arista as long as from its base to vertex; face opaque black, almost perpendicular in profile; cheek black, of almost equal height on its entire length, and not over one-sixth the height of eye, marginal bristles numerous and of moderate size, carried higher in front than level of the differentiated vibrissae; proboscis brown; palpi black, very slightly broadened at ends, and weakly bristled; occiput not projecting. Mesonotum glossy black, with a slight greenish or bluish tinge; two pairs of dorso-centrals present; squamae very dark, the margin almost black, fringe blackish. Abdomen concolorous with mesonotum; the posterior margin of sixth segment with rather long bristles; base of ovipositor highly glossy, the surface

\*Bull. Cal. State Com. Hort., Vol. I, No. 10, p. 730, 1912.

†Verh. zool-bot. Ges. Wien., Vol. II, 1861, p. 484.

bare except apically on sides, as long as the elongate sixth segment. Legs shining black; the posterior bristles on mid tibia distinct. Wings grayish; veins black-brown; subcostal vein distinct, fused with first at its apex; outer cross vein at wing middle, and at its own length from inner cross vein; inner at distinctly beyond middle of discal cell; last section of fifth vein not two-thirds as long as penultimate section; veins 3-4 slightly divergent at apices. Halteres black.

Length 2 mm.

Type: Cat. No. 15588, U. S. N. M.

Locality: Frontera, Tabasco, Mexico, March, (C. H. T. Townsend). One female.

Food-plant unknown.

### 53. *Agromyza tilia* Couden.

Syn: *Agromyza tilia* Couden, Proc. Wash. Ent. Soc., Vol. IX, 1907, p. 34.

Female: This species is very similar to *A. websteri*, but differs as follows: The antennae are smaller, the third joint being rather below the average size; the arista is not so distinctly thickened at the base, nor for such a long distance, the thickening tapering gradually; the mesonotum is shining black; with two pairs of dorso-centrals; the pleurae, scutellum, and abdomen glossy black; the squamae and legs are similar in color to *websteri*, but the mid tibiae has the posterior bristles distinct, though small; and in size *tilia* averages less, 2-3 mm. The venation in both species is rather variable, but the outer cross vein is generally at less than its own length from the inner.

The type series which is in rather poor condition, was reared from the galls on twigs of lime trees. Locality: Jennings, Missouri, March-April, 1907, (Mrs. Hickey).

The twig in collection shows the galls arranged on the surface, independent of the position of the leaf buds, whereas in *websteri* the galls are apparently confined to the bases of the buds. There are two specimens in collection, one male Veitch, Virginia, June 9, 1912, (F. Knab), and one female, Delaware County, Pennsylvania, July 23, 1892 (no collector's name), the former at least of which belongs to this species.

### 54. *Agromyza schineri* Giraud.

Syn: *Agromyza schineri* Giraud, Verh. zool.-bot. Ges. Wien, Vol. II, 1861, p. 484.

Male and Female: This species is very similar to *tilia* but differs as follows: The frons is distinctly broader, being over one-third as wide as head; the orbits are broader, the ocellar triangle is broader and shorter than in *tilia*, the ocelli not forming an equilateral triangle as in that species, the distance between the posterior pair being distinctly greater than that between those and the anterior one; the

arista is comparatively shorter and more distinctly swollen in *schineri* than in *tilia*; and the posterior surface of mid tibia in *schineri* has no distinct bristles.

Length 2-2.5 mm.

Originally described from Europe.

Locality of specimens in U. S. National Museum collection: Toronto, Canada, (collection W. Brodie); I have seen two specimens reared from galls on Poplar by C. A. Frost, Framingham, Massachusetts, submitted by C. W. Johnson.

55. *Agromyza congregata*, new species.

Male: This species is very similar to *tilia*, but differs as follows: The orbital bristles are four in number, strong and equally spaced; the cheeks are comparatively higher, being at center rather more than one-third the height of eye; the marginal mouth bristles are strong, and form a group at the anterior angle of cheek, amongst which the vibrissa is hardly distinguishable; the entire color of insect is a deep black; the legs are strong and there is no trace of the posterior bristles on the mid tibia; the wing venation is similar to *tilia*.

Length 1.75 mm.

Type: Cat. No. 15589, U. S. N. M.

Locality: Williams, Arizona, May, (H. S. Barber), one male.

Food-plant unknown.

56. *Agromyza minima*, new species.

Male: Frons black, center stripe opaque, orbits and frontal triangle glossy; breadth of frons one-third that of head; orbits narrow, each not one-fourth as wide as center stripe; four rather weak orbital bristles present, the orbits with additional short hairs; face black, opaque, concave in profile, mouth margin produced; cheek black, short, highest at center, where it is about one-fourth as high as eye; marginal bristles of moderate strength, the vibrissa weakly differentiated; occiput not projecting; antennae of moderate size; third joint regularly rounded, distinctly shorter than broad; arista not much swollen at base, tapering, almost bare, its length equal to from its base to almost upper orbital bristle. Mesonotum glossy black, with a slight bluish tinge; two pairs of dorso-centrals present; pleurae concolorous with disk of mesonotum; squamae gray, margin and fringe brown. Abdomen glossy black, with a distinct metallic bluish tinge. Legs black; the posterior mid tibial bristles distinct, though small. Wings grayish; inner cross vein at slightly beyond end of first vein, and at slightly beyond middle of discal cell; outer cross vein at about its own length from inner, and at slightly beyond wing middle; last section of fifth vein barely more than one-half as long as penultimate section; veins 3-4 almost parallel on their last section.

Length slightly over 1 mm.

Type: Cat. No. 15590, U. S. N. M.

Locality: Trinidad, West Indies, June, (A. Busck).

Paratypes: Three females. Those are identical with the male in all essential characters. Localities: Mayaguez, Porto Rico, January, 1899 (A. Busck); Utica, Mississippi, August (no other data); and one specimen taken on flowers of *Bige-  
lavia graveolans*, Mescalero, Mexico, October 2, 1896 (T. D. A. Cockerell). Food-plant unknown.

Williston's description of *Agromyza anthrax*.

Trans. Ent. Soc. Lond. 1896, p. 430.

**"Agromyza anthrax, n. sp."**

"Male: Black, but little shining. Front very broad, nearly square, its width rather exceeding its length; opaque black, on its lower margin yellowish. Antennae black, third joint rounded, large, pubescent, arista very short pubescent. Face receding, excavated, not at all visible from the sides; cheeks linear, with black bristles along the oral margin, and a rather stout vibrissal bristle in front. Palpi projecting beyond the oral margin, yellow. Mesonotum and scutellum a little shining. Abdomen opaque, oval. Halteres yellow. Knees and tarsi yellow, the distal joints of the latter brownish. Wings lightly tinged; the third vein terminates in the apex of the wing; penultimate section of fourth vein about one-third as long as the ultimate section of fifth."

"Length  $1\frac{1}{2}$  mm."

"One specimen, St. Vincent."

Owing to the omission to mention the number of dorso-central bristles in this species, and some other essential characters, I cannot place this species in my synoptic table, but in general appearance it must approach very closely to *varifrons* Coquillett.

Williston's description of *Agromyza innominata*.

Trans. Ent. Soc. Lond. 1896, p. 443.

**"Agromyza innominata, n. sp."**

"Male: Head yellow, a blackish spot at the ocelli; front broad. Antennae yellow; third joint longer than broad; arista finely pubescent. Face short, gently excavated in profile; cheeks rather broad. Palpi elongate, dilated. Thorax obscurely reddish yellow; mesonotum with black hairs. Scutellum large, with two stout, remote, black bristles. Abdomen brown or blackish, yellowish at base. Legs light yellow; hind femora black at the immediate tip. Wings cinereous hyaline; basal cells complete; penultimate section of fourth vein a little longer than the posterior."

"Length  $1\frac{1}{4}$  mm."

"One specimen."

"Locality: St. Vincent, West Indies."

I have not seen this species, and cannot place it in my synoptic table from the characters given in the description. No species of *Agromyza* that I have seen has only two scutellar bristles, and the palpi are remarkably large for a species of this genus. The head, with the exception of the palpi, as figured, looks like an *Agromyza*, but the arista is rather strongly pubescent, for most of the species in that genus. I suspect that it does not belong here, and the head figured on page 292 in Williston's Manual, which is quite evidently a reproduction of his figure 158 on Plate 14 of the original publication of the description, being given as "*Agromyza* (nov. gen.?)" in the Manual, would seem to indicate that Williston also thought so in 1903, whatever he may have thought in 1896. No indication is given as to the specific identity of the species, or source from which figure came in the Manual.

Lundbeck's description of *Agromyza arctica*.

Vidensk. Meddel. Copenhagen, 1899, p. 304.

"148. *A. arctica* n. sp. Fig. 4."

"*Brunneocinerea*, thorace opaco, abdomine subnitido, lateribus thoracis maculis flavis ornatis, lateribus abdominis flavis, segmentis abdominis margine posteriore anguste flavescente. Pronte sordide flava, lunula supra antennis flava; antennis flavis, basi et margine exteriori articuli tertii brunnescentibus, arista nigra. Epistomate flavo. Alis hyalinis, leviter flavescentibus, nervo longitudinali quarto in apice alae excurrente, costa ad apicem nervi longitudinali quarti producta. Halteribus flavis. Pedibus cinerascenscentibus, geniculiset lateribus inferioribus femorum flavis. ♂ ♀. Long. 2 mm.

"*A. geniculatae* affinis. Mas. *Brunneocinereus*, thorax opacus, abdomen subnitidum, thorax longe sed parce pilosus, abdomen brevius pilosum, scutellum in margine posteriore quattuor setis longis instructum; latera thoracis dilute cinerea, maculis flavis ornata, latera abdominis tota flava, margines posteriores segmentorum anguste flavescentes (saepae obsolete), metanotum sub scutellum linea flava ornatum. Frons sordide flava, supra antennis lunula flava. Antennae flavae, basi et margine doreali articuli tertii brunnescentibus, arista nigra. Epistoma flavum, occiput brunneogriseum. Alae hyalinae, leviter flavescentes, nervus longitudinalis secundus et tertius leviter arcuati, ad apicem reflexi, nervus longitudinalis quartus rectus, in apicem alae excurrente, costa ad apicem nervi longitudinali quarti producta, nerve transversali appropinquati, posterior ante mediam alam situs. Halteres flavi. Pedes cinerei, geniculis et femorum lateribus inferioribus flavis sive refuscentibus. Fem. Mari similis, abdomen ovipositorum conico, nigrobrunneo, valde nitido, daubus lamellis nigris, parvis terminato."

"Individua plures adsunt colore toto et praesertim abdominis dilutius versimiliter immatura."

"Synes at forekomme temmelig almindelig langs hele Vestkysten idet mindste op til 69° N. Br.; træffes især i Pilekrattet, Larven lever maaske i Pileblade. Igaliko-Fjord, Tunugdliarfikfjord, Tassiusak Kristianshaab, Sydostbugten (Forf.).

This species bears a resemblance to *borealis* described on a previous page, the venation being almost identical in Lundbeck's figure with that given in this paper for *borealis*, but his description is lacking in several essentials, so that it is not possible to say definitely whether the species are really the same or not.

#### *Cerodontha* Rondani.

Syn: *Cerodontha Rondani*, Dipt. Ital. prod. Vol. IV, 1861, p. 10.

*Odontocera* Macquart, Suit a Buffon, Vol. II, 1835, p. 615 (Proce.).

*Ceratomyza* Schiner, Wien. entom. Monatschr. Vol. VI, 1862, p. 434.

#### Characters of the Genus.

Similar in most respects to *Agromyza*, but the third antennal joint terminates, on the upper surface, in a thorn-like point. The frontal and thoracic bristling is similar in nature to that of *Agromyza*, but in no case have I seen more than two scutellar bristles on the species I have examined; nor do I know of any species in which more than two are present. The mid tibia has no posterior bristles, and the costa always reaches to the fourth vein.

#### *Cerodontha dorsalis* Loew.

Plate XXXI, Figs. 33, 39.

Syn: *Odontocera dorsalis* Loew, Dipt. Amer. Sept., Indig., Cent. I. 1861, species 99.

Male and Female: Frons yellow, opaque, in breadth about one-half that of head; orbits sometimes blackened, very narrow, on upper half each not over one-sixth as wide as center stripe; three distinct orbital bristles present, and on lower portions a few short hairs; proclinate ocellar bristles parallel, or slightly divergent, separated at base by as wide a space as posterior ocelli; antennae yellow, third joint black, one and one-half times as long as broad, ending in a thorn-like point on upper side; arista black, distinctly thickened at base and tapering to near its middle, pubescence indistinguishable, length of arista short of twice the length of antennae; face yellow, slightly concave, central keel rounded; cheeks yellow, higher posteriorly than anteriorly, and at highest point about one-half as high as eye, marginal bristles distinct; vibrissa strong, differentiated from marginal bristles; proboscis and palpi yellow; occiput unprojecting on upper half. Mesonotum with disk entirely glossy black, with sometimes an indication of grayish

pollen, or with the central portion in front of scutellum yellow, more rarely with two narrow black stripes on sides, and the central yellow portion carried forward at its anterior margin, slightly beyond middle, as narrow lines which more or less distinctly intersect the broad discal black mark, giving the disk the appearance of having five stripes, or a pattern somewhat similar to that of *Agromyza melampyga*; lateral margins of mesonotum broadly yellow; humeri with a black spot; four pairs of dorso-central bristles on mesonotum; no setulae on disk; pleurae yellow with black varigations; squamae yellow, the fringe brownish or grayish; scutellum all black or with the disk yellow, two scutellar bristles present. Abdomen from almost entirely yellow to almost entirely black, posterior margins of segments narrowly yellow. Legs slender, yellow, sometimes with fore tibiae and tarsi blackened, all tarsi brownish. Wings as figure.

Length 2-2.5 mm.

The following is a list of the States from which I have seen specimens: Connecticut, Massachusetts, Iowa, Florida, Georgia, District of Columbia, Kentucky, Indiana, Nevada, New Mexico, Texas, Utah, Washington, Tennessee, Nebraska, Michigan, Illinois and California.

I have also seen specimens from Mexico and Porto Rico. The larva mines the stems of grains and grasses.

#### ADDENDA.

##### *Agromyza quadrisetosa*, new species.

Female: Back subshining. Head yellow, ocellar spot, upper third of orbits, back of head, 3rd antennal joint, palpi and upper mouth margin black. Mesonotum with lateral margins broadly pale, whitish yellow, humeri with a black spot; pleurae with upper margin concolorous with margin of mesonotum; scutellum yellow, margined on sides with black, squamae yellow. Abdomen black, glossy, the segments with narrow, yellow, posterior margins. Legs entirely shining black. Wings clear, basal portion of veins pale yellow, outer portions brownish. Halteres yellow.

Frons about one and one-third times as long as broad at vertex; orbits glossy, six orbital bristles present, incurved, situated on middle of orbit and of good length; orbits otherwise bare; antennae of moderate size, third joint rounded, second joint with dorsal bristle distinct; arista tapering, bare, brown in color, equal in length to from its base to second uppermost orbital bristle; checks at anterior margin about equal in height to breadth of third antennal joint, at posterior margin equal to slightly more than half of the height of the eye. Mesonotum with 4 pairs of dorso-centrals, between which are 2-3 irregular rows of setulae which do not extend to posterior dorso-centrals; scutellar bristles (4) subequal. Abdomen with apices of all segments armed with rather strong bristle-like hairs. Legs with mid tibial posterior bristles absent or very weak. Wings with costa to fourth vein; veins 3-4

divergent; outer cross vein at less than its own length from inner and but little beyond end of first vein; last section of fifth vein twice as long as penultimate section

Length 2 mm.

Type: Cat. No. 15957, U. S. N. M.

Type locality: San Antonio, Texas, April 8, 1907 (F. C. Pratt). Nothing recorded of early stages.

This species belongs to the *pusilla* group, but may readily be separated from any of those in this paper by the black palpi, third antennal joint and legs. It is distinct from any of the European species I have examined.

*Agromyza melampyga* Loew.

This species has been bred by C. R. Jones at San Antonio, Texas, from root of *Plantago media*.

*Agromyza citreifrons* Malloch.

I had some doubt as to the distinction of this species from *hilarella* Zetterstedt, but I have since examined specimens belonging to the National Museum in Budapest, and consider them quite distinct. *Hilarella* has the frons darker than *citreifrons*, the antennæ darkened on upper surface of third joint, the face less receding, the eyes longer than high, the wings narrower, the inner cross vein distinctly before middle of discal cell, and the last section of fifth vein very distinctly longer than the penultimate section.

*Agromyza longipennis* Loew.

I have examined specimens from Europe, of *geniculata* since writing the above, and find they are distinct from *longipennis* in having the legs less broadly yellow on joints, the arista almost bare, as against the distinct pubescence of *longipennis*, and the last section of fifth vein distinctly shorter than penultimate section.

*Agromyza angulata* Loew.

Two specimens submitted as *luctuosa* Meigen from Budapest represent two distinct species, one of which is very close to *angulata* Loew. Under the circumstances I consider that it is not desirable to question the retention of *angulata* as the name for the American species.



*Agromyza abnormalis* Malloch.

This species differs from *obscuritarsis* Rondani in being more robust, darker in color throughout, and particularly in that the frons and halteres, and in neuration, the last section of fifth vein in *obscuritarsis* being about one and one-half times as long as penultimate section. Both species have 4 pairs of dorso-centrals.

*Agromyza kincaidi* Malloch.

On comparison of the type of this species with specimens submitted from Budapest museum as *nigripes*, I find that the European form has over all a more glossy black color, the frons is much narrower, being barely wider than width of either eye, and narrowed anteriorly, the arista is almost bare, the squamae are darker, with brown fringes, and the last section of fifth vein is almost as long as the penultimate section.

An example from Hampton, N. H. (S. A. Shaw) agrees in almost every particular with those from Europe so that this species may be added to the American list and the name changed to *subnigripes* n. nom. for the reasons stated in this paper.

*Agromyza pruinosa* Coquillett.

This species has been reared from larvae mining under bark on birch trees by C. T. Green of the Division of Forest Insects, at Falls Church, Va. I have examined two males which agree in every particular with the type, except in being rather larger.

*Agromyza carulea* Malloch.

I have examined a series of 8 specimens reared from *Ipomoea sinuata* and 5 from *Ipomoea lacunosa*, at Victoria, Texas, in September, 1907, and 7 from same locality August, 1907, labelled *Ipomoea*, by J. D. Mitchell. They agree with the Mexican specimen in all particulars.

*Agromyza texana* Malloch.

Two pairs taken in copula at Kerrville, Texas, June 19, 1907 (F. C. Pratt).

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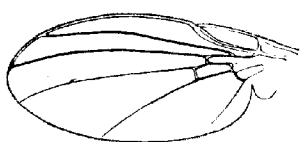
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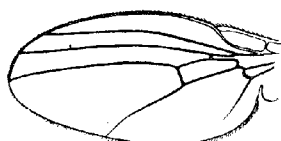
The Plates were drawn by W. R. Walton, with the exception of Figures 14, 15, 30, 31, and 38, which are by the author.



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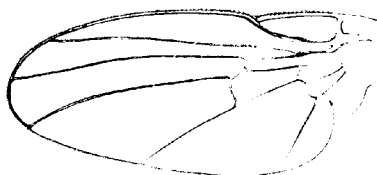
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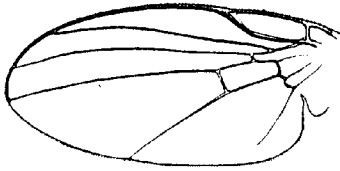
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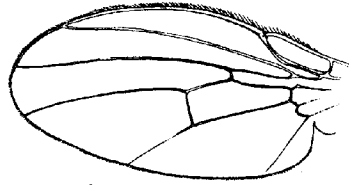
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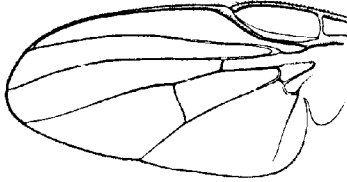
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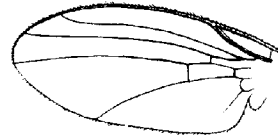
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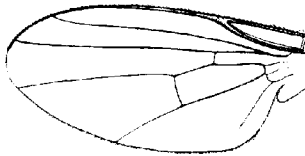
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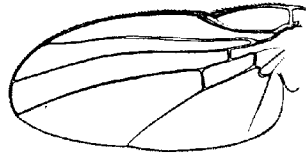
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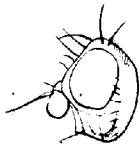
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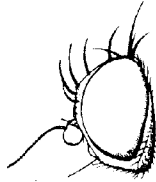
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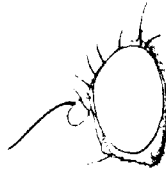
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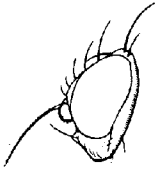
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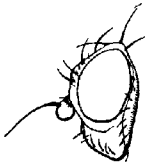
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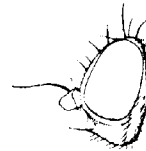
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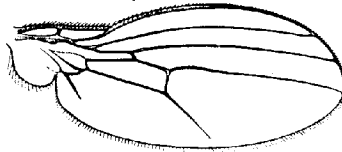
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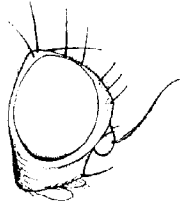
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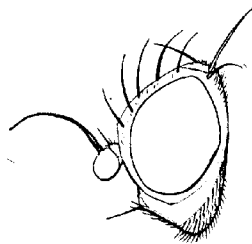
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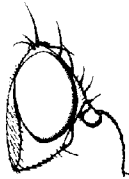
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## THE WING VENATION OF THE FULGORIDÆ.

Z. P. MEICALE.

The present paper is a continuation of my work on the homologies of the wing veins of Homopterous insects, a paper having previously been published on the wing venation of the Jassidæ.\*

The present paper is based upon a study of the wing pads of eleven genera of Fulgoridæ. These eleven genera are distributed among seven of the eleven commonly recognized sub-families of Fulgoridæ. Two of the sub-families not represented in this study are not found in our territory and I have not been able to secure representatives of the two remaining sub-families, *Achilida* and *Fulgorida*. The venation of these two sub-families presents no special difficulties when viewed in the light of our knowledge of other Fulgoridæ which have been carefully studied.

The same technique has been used in preparing the material for studying the wing venation of the Fulgoridæ that was used for studying the Jassidæ. The nymphal wings being removed as carefully as possible were mounted in water. The wing pad was then either drawn with the aid of a camera lucida or a photomicrograph made. Afterward a pen and ink drawing was made from the photomicrograph uniform with the camera lucida drawings. The drawings of the adult wings were made from balsam mounts with the aid of the Edinger drawing apparatus. The magnifications used in both cases varied greatly being adapted as far as possible to the needs of individual cases.

The relation of the main tracheæ of the wing pads to the body tracheæ is an interesting one and one upon which much stress has been laid in the past. The relationships of the main tracheæ of the wing pads can be much better understood if they can be traced back to their origin from the main body tracheæ.

Unfortunately, however, the wing pads of most insects are so placed that the body tracheæ lie very deep. This makes it practically impossible to secure the body tracheæ by the

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\*ANNALS of the Entomological Society of America, Vol. VI, No. 1.



ordinary methods\* of dissection. If the wing is carefully removed, however, the relationships of the main tracheæ need not be disturbed. Some emphasis has also been placed on the fact that in some families the tracheæ of the wing pads arise from a single basal trachea, whereas in certain other families the radio-medial group of tracheæ arises from a cephalic body trachea while the cubito-anal group arises from a caudal body trachea. In certain cases this character has been used to indicate that one family is more primitive structurally than another. That such a position is untenable is clearly shown in at least two genera of the Fulgoridæ in which I was so fortunate as to secure enough of the body tracheæ as to determine this point. In *Thionia* (Figs. 27, 28) the tracheæ of the fore wing pad arise from a single body trachea while the tracheæ of the hind wing pad arise from a cephalic and a caudal body trachea. In *Amphiscepa* (Figs. 5, 6), on the other hand, the tracheæ of the fore wing arise from two body tracheæ whereas the tracheæ of the hind wing arise from a single body trachea.

#### THE FORE WING.

Unlike the fore wings of the Jassidæ, the fore wings of the Fulgoridæ are exceedingly variable. As is well known, the adults of many Fulgoridæ occur in two forms, a long-winged or *macropterous form*, and a short-winged or *brachypterous form*. This is especially true of certain genera. While the problem of the origin and significance of this variation is an exceedingly interesting one, it has not been taken into consideration in this paper, and as a rule, only *macropterous forms* have been considered with the exception of a few cases where the *brachypterous forms* are the usual ones.

The wings of the Fulgoridæ show two marked forms of specialization from the hypothetical type, the one by the addition of accessory branches to the main veins and the other by the reduction of the number of branches of the main veins. The one may be known as specialization by addition, and the other as specialization by reduction. An almost perfect series can be traced from the one extreme to the other. Forms like *Ormenis* (Fig. 13), show a great specialization by addition as is found in any insect of any order, while forms like *Bruchomorpha* (Fig. 33), show a great deal of specialization by re-

duction. While the wing venation of most of the insects that have been studied extensively so far can be reduced to a more or less uniform type for the family, in the Fulgoridæ no such typical form can be given. In the following discussion of the individual tracheæ the differences in the characters of the same trachea in different genera will not be emphasized so much as their resemblances.

#### *The Costa of the Fore Wing.*

The costa of the fore wing is usually present in the Fulgoridæ, in fact it was found in practically every genus studied. Typically, costa is a single unbranched trachea usually of somewhat less extent than subcosta. In *Ormenis* (Fig. 3), however, there are many small lateral tracheæ formed along the entire length of the costal trachea, and in *Amphiscepa* (Fig. 5), the tip of the costal trachea breaks up into several smaller tracheæ. In *Thionia* (Fig. 27), the costal trachea shows a strong lateral branch near its base. This branch runs parallel with the main branch of costa and seems to be included in the same forming vein.

#### *The Subcosta of the Fore Wing.*

The subcosta has been found present in all of the genera studied. In many of the genera subcosta is a larger and more important trachea than radius. In nearly all cases it lies parallel with radius for the greater part of its length, while in *Scolops* (Fig. 23), it lies parallel with radius for its entire length. Subcosta is typically two branched in the *Delphacida* (Figs. 43, 45), and in the *Cixiida* (Fig. 47), while in *Amphiscepa* (Fig. 5), and *Ormenis* (Fig. 3), the tip of the subcosta breaks up into several small tracheæ.

#### *The Radius of the Fore Wing.*

Radius in the Fulgoridæ occupies a much less important position than in the wings of most other insects which have been studied in detail up to the present time. In most cases the radial trachea lies parallel with the subcostal trachea and usually only a single vein is formed in the region occupied by these two tracheæ. In *Stobæra* (Fig. 45), radius is a single unbranched trachea lying parallel with subcosta for more than half of its length then diverging and running parallel with one of the branches of medius for a short distance it

diverges toward the costal border. Radius occupies a somewhat similar position in *Myndus* (Fig. 47), except that there are three or four small branches near the tip and the trachea does not coalesce with medius in any part of its course. The condition of the radial trachea in *Dictyophara* (Fig. 25), is almost identical with that in *Myndus*, except that there are small lateral branches toward the tip. In *Thionia* (Fig. 27) and *Scolops* (Fig. 23), the radial trachea is quite similar in appearance to that in the genera discussed above except that separate veins are formed along these two trachea in *Thionia*. In both of these genera the lateral branches near the tip are much weaker and more uncertain in their position and are not the fore-runners of typical and fairly constant longitudinal veins, but of rather uncertain cross veins which are fairly common in these genera. In *Amphiscepa* (Fig. 5), and *Acanalonia* (Fig. 1) radius is a single unbranched trachea. In *Ormenis* (Fig. 3), the radial trachea consists of two main trachea which separate into several smaller branches before reaching the tip.

#### *The Medius of the Fore Wing.*

In all the genera studied the medial trachea is the most important trachea of the fore wing and its branches occupy more area than the branches of any other trachea. In the genera studied medius seems to be typically four branched only in *Amphiscepa* (Fig. 5). Each one of these branches, however, branches one or more times before reaching the tip of the wing. In *Ormenis* (Fig. 3), medius divides into two branches each branch again dividing into two branches. Each of these branches, however, is several times divided before reaching the tip of the wing pad. In *Acanalonia* (Fig. 1), medius is three branched, these branches representing medius one, medius two and medius three plus four. In *Scolops* (Fig. 23), *Dictyophara* (Fig. 25) and *Thionia* (Fig. 27), medius is typically two branched, although these branches may divide one or more times before reaching the tip of the wing pad. The veins which form along these secondary branches are not at all constant in position and relative importance. In *Stobæra* (Fig. 45), medius divides into two main branches. These branches represent medius one plus two and medius three plus four, medius one and medius two separating before reach-

ing the tip of the wing pad. In *Myndus* (Fig. 47), medius is typically four branched with an accessory branch between medius one and medius two.

*The Cubitus and the First Anal of the Fore Wing.*

As in the Jassidæ the cubital-first anal group forms the most characteristic land-mark in the tracheation of the Fulgoridæ. These two trachea are united for a short distance from the body trachea and cubitus is usually two branched. In *Thionia* (Fig. 27), *Dictyophara* (Fig. 25) and *Acanalonia* (Fig. 1), cubitus is unbranched, while in *Phylloscelis* (Fig. 7), cubitus is two branched and in *Stobæra* (Fig. 45), there is an accessory branch between cubitus one and cubitus two.

*The Second and Third Anal of the Fore Wing.*

The second anal trachea is a simple unbranched trachea and usually lies parallel with the first anal trachea. The third anal trachea is nearly always present in Fulgoridæ and is usually two branched. The second branch when present usually forms the anal border of the fore wing.

THE HIND WING.

The hind wing of the Fulgoridæ is almost as variable as the fore wing, very little similarity being observed in the different genera of some of the sub-families. Quite a little variation is frequently observed in different individuals of the same species.

*The Costa of the Hind Wing.*

The costal trachea is present in the following widely separated genera: *Myndus* (Fig. 48), *Scolops* (Fig. 24), *Dictyophara* (Fig. 26), *Thionia* (Fig. 28), *Acanalonia* (Fig. 2), and *Phylloscelis* (Fig. 8). In *Thionia*, *Phylloscelis* and *Myndus* it is united with subcosta for some distance from the body trachea. In *Scolops* it is present only as a weak trachea at the base of the wing.

*The Subcosta of the Hind Wing.*

The subcostal trachea was found in all the wing pads studied. In most of the genera it runs parallel with radius for almost its entire length and diverges at the tip. The radial and subcostal tracheæ are included in a common vein

except at the tip where subcosta diverges and the vein which forms along this tip in the adult resembles a branch of the radial vein. This condition is especially apparent in *Stobæra* (Fig. 46), *Myndus* (Fig. 48), *Dictyophara* (Fig. 26) and *Amphiscepa* (Fig. 6). In *Scolops* (Fig. 24), subcosta appears merely as a weak trachea lying parallel with radius along its base.

*The Radius of the Hind Wing.*

In nearly all cases radius of the hind wing is a single unbranched trachea. In certain genera, however, such as *Scolops* (Fig. 24), *Dictyophara* (Fig. 26) and *Acanalonia* (Fig. 2), radius shows more or less tendency to branch near the tip. These branches are rather variable as an examination of different individuals of the same species clearly shows. Therefore I have made no attempt to homologize these branches.

*The Medius of the Hind Wing.*

A typical medius of the hind wing of Fulgoridæ is two branched, but frequently these branches show a decided tendency to branch again before reaching the tip of the wing pad. In *Stobæra* (Fig. 46) and *Thionia* (Fig. 28) medius is a simple unbranched trachea which in *Stobæra* runs parallel with cubitus for a considerable distance, the veins of the adult coalescing at this point.

*The Cubitus of the Hind Wing.*

In many genera cubitus of the hind wing occupies the greatest area and bears somewhat the same relationship to the other tracheæ of the hind wing that medius bears to the other tracheæ of the fore wing. In *Myndus* (Fig. 48) and *Phylloscelis* (Fig. 8), cubitus is unbranched. In *Stobæra* (Fig. 46), *Thionia* (Fig. 28) and *Scolops* (Fig. 24) cubitus is typical. In the other genera studied cubitus has two principal branches, each of which bears one or more accessory branches.

*The Anals of the Hind Wing.*

The first anal of the hind wing bears the same relation to cubitus that it does in the fore wing. The second anal trachea is usually simple and unbranched, and lies parallel with the first anal. The third anal trachea has been found in all of the genera studied and is usually branched. Although in some cases *Thionia*, *Dictyophara* and *Scolops* the third anal trachea is three branched.

## SUMMARY.

Owing to the fact that the adult wings of the *Fulgoridae* vary so much it has seemed best to summarize the homologies of adult wing veins by giving a discussion of the characters of the adult wings of the various subfamilies.

Sub-family **Fulgorida**.

Both the fore and hind wings of this sub-family are characterized by a large amount of reticulation. Nearly all the members of this sub-family are characterized by having a large number of accessory veins. These accessory veins may be added to radius, medius or cubitus, but in some cases, as in *Poicocera* (Fig. 9) all three of these veins bear accessory veins. In the hind wing radius and medius do not usually bear many accessory veins, but cubitus usually has several accessory veins. Another characteristic of the hind wings is the fact that the cross veins are apt to be connected together forming false veins between the principal veins. These false veins usually lie along the folds of the wing.

Sub-family **Flatida**.

The chief characteristics of this sub-family are: First, that the costal vein is remote from the costal border of the wing and connected with it by means of a number of cross veins; second, that radius and medius are provided with a large number of accessory veins; and third, that these accessory veins are usually connected by a definite series of cross veins at a uniform distance from the apical border of the wing. The hind wing is chiefly characterized by the great development of the anal area of the wing, and by a large number of accessory veins attached to cubitus.

Sub-family **Acanaloniida**.

The fore wings of the members of this sub-family are characterized by having a large number of cross veins between the branches of the principal veins. They are also characterized by having radius simple and unbranched, and the larger area of the wing occupied by the branches of the medius. In some cases, *Amphisceps* (Fig. 15), medius is typically four branched with the addition of accessory veins to some of the branches. In other cases, *Acanalonia* (Fig. 17), medius is three branched,

the branches representing medius one, medius two and medius three plus four. The hind wing is characterized by the great development of cubitus, and the fact that in certain cases, *Amphiscepa* (Fig. 16), radius and medius coalesce for a considerable distance from the base of the wing.

#### Sub-family **Achilida.**

The fore wings in this sub-family are characterized by the fact that subcosta and radius are coalesced for a considerable distance from the base, and the fact that there are usually several cross veins between subcosta and the costal border of the wing. Radius and medius offer no special characters and cubitus is typically two branched, although there are frequently accessory cross veins between cubitus two and the anal border of the wing.

#### Sub-family **Dictyopharida.**

The chief characteristics of this sub-family are to be found in the complete or all but complete coalescence of subcosta and radius. In *Scolops* (Fig. 29), they are completely coalesced. In *Dictyophara* (Fig. 31), nearly completely coalesced, but in *Phylloscelis* (Fig. 22), are not coalesced except for a short distance at the base. Medius is typically two branched, but in *Scolops* (Fig. 29), there are several accessory branches. In *Scolops* (Fig. 29), and *Dictyophara* (Fig. 31), cubitus is typically two branched, but in *Phylloscelis* (Fig. 22), cubitus bears several accessory branches.

#### Sub-family **Issida.**

I have studied only a few genera in this sub-family. In *Thionia* (Fig. 35), all of the branches of the principal veins are reduced, medius alone being typically two branched. All of the veins are connected by a number of cross veins. In *Bruchomorpha* (Fig. 33), a study of the adult wing alone seems to indicate a condition closely approximating the condition found in the Delphacida, in which radius and medius are coalesced for a considerable distance, radius diverging strongly and coalescing with medius throughout the middle of its course, and then diverging strongly toward the costal border of the wing. In all of the Issida that I have examined second and third anal are coalesced for nearly half of their course at

the tip. In *Thionia* (Fig. 36), the anal area of the hind wing is larger than the preanal area, and third anal is characterized by the addition of a large number of accessory veins. In *Bruchomorpha* (Fig. 34), the hind wing is greatly reduced in area, and the principal veins only are represented by simple unbranched veins.

#### Sub-family **Derbida.**

In this sub-family, also, subcosta and radius are coalesced for a considerable distance from the base, and both are typically two branched; although in some cases, *Otiocerus* (Fig. 39), there are a number of cross veins between subcosta and the costal border. Medius is typically four branched with a number of accessory veins added to medius one. In *Anotia* (Fig. 37), and *Otiocerus* (Fig. 39), there is an accessory vein between medius three and four. In *Lamenia* (Fig. 41), there are no accessory veins between medius three and medius four, and only a single accessory vein between medius one and medius two. Cubitus is typically two branched, but in *Otiocerus* and *Anotia* these branches do not extend to the anal border of the wing, but unite with the coalesced anals at some little distance from the border of the wing. In the hind wings, subcosta and radius are coalesced, and medius is two branched in *Anotia* (Fig. 38) and *Otiocerus* (Fig. 40), but unbranched in *Lamenia* (Fig. 42). Cubitus of the hind wing is two branched in all of the members of this sub-family which I have examined.

#### Sub-family **Cixiida.**

This sub-family also is characterized by the fact that subcosta and radius are coalesced for some distance from the base. Subcosta is typically two branched, although in *Bothriocera* (Fig. 60), *Oliarus* (Fig. 58) and *Æcleus* (Fig. 62) supernumerary veins are added between subcosta one and subcosta two. Radius is typically three branched, although these branches are somewhat variable in their relationships. Medius is typically four branched with an accessory vein between medius one and medius two, although in *Oliarus* (Fig. 58), both medius one and medius two bear accessory veins. Cubitus of the fore wing is typically two branched, and second and third anals are coalesced at the tip. In the hind wing subcosta and radius are coalesced for a considerable distance from the base,



and radius has two branches except in *Myndus* (Fig. 56). Medius is typically three branched except in *Ecleus* (Fig. 63), where it is only two branched. Cubitus is unbranched in *Myndus*, and two branched in all of the other members of this subfamily that I have examined.

#### Sub-family **Delphacida.**

In the fore wing, subcosta is typically two branched. Radius is coalesced with subcosta for about half of its length, when it diverges suddenly, then coalesces near the middle of its course with medius one plus two. It then diverges toward the costal border of the wing. Medius is typically three branched, the branches represented being medius one, medius two and medius three plus four. Medius three plus four frequently coalesces for a short distance with cubitus one, as in *Liburnia* (Fig. 53) and *Stenocranus* (Fig. 49). In *Stobæra* (Fig. 51), these two veins are connected by a short cross vein. Cubitus is three branched an accessory vein being developed along the anal side of cubitus one. In the hind wing, subcosta and radius are coalesced for more than half of their length and medius is unbranched. Cubitus is typically two branched, cubitus one coalescing for almost its entire length with medius, being separated only at its tip. The anal area of the hind wing is considerably enlarged and the third anal is frequently three branched.

#### ACKNOWLEDGEMENTS.

The writer wishes to express his appreciation for the kindly advice of Professor Herbert Osborn, and for the helpful criticisms of C. L. Metcalf, who furnished, also, the specimens of *Myndus radialis*, Osb., the only species of the subfamily Cixiida available for study. C. S. Brimley and Rev. A. H. Manee have furnished some material, but Luella Correll Metcalf has collected most of the material which was used as a basis for this paper.

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## EXPLANATION OF PLATES.

## PLATE XXXII.

- |         |                  |                               |
|---------|------------------|-------------------------------|
| Fig. 1. | Fore wing pad of | Acanalonia sp.                |
| Fig. 2. | Hind "           | Acanalonia sp.                |
| Fig. 3. | Fore "           | Ormenis septentrionalis Spin. |
| Fig. 4. | Hind "           | Ormenis septentrionalis Spin. |
| Fig. 5. | Fore "           | Amphiscepa bivittata Say.     |
| Fig. 6. | Hind "           | Amphiscepa bivittata Say.     |
| Fig. 7. | Fore "           | Phylloscelis atra Germ.       |
| Fig. 8. | Hind "           | Phylloscelis atra Germ.       |

## PLATE XXXIII.

- |          |              |                               |
|----------|--------------|-------------------------------|
| Fig. 9.  | Fore wing of | Poicocera fuliginosa Uhl.     |
| Fig. 10. | Hind "       | Poicocera fuliginosa Uhl.     |
| Fig. 11. | Fore "       | Cyrcoptus belfragei Stal.     |
| Fig. 12. | Hind "       | Cyrcoptus belfragei Stal.     |
| Fig. 13. | Fore "       | Ormenis septentrionalis Spin. |
| Fig. 14. | Hind "       | Ormenis septentrionalis Spin. |
| Fig. 15. | Fore "       | Amphiscepa bivittata Say.     |
| Fig. 16. | Hind "       | Amphiscepa bivittata Say.     |
| Fig. 17. | Fore "       | Acanalonia latifrons Walk.    |
| Fig. 18. | Fore "       | Elidiptera opaca Say.         |
| Fig. 19. | Hind "       | Elidiptera opaca Say.         |
| Fig. 20. | Fore "       | Catonia sp.                   |
| Fig. 21. | Hind "       | Catonia sp.                   |
| Fig. 22. | Fore "       | Phylloscelis atra Germ.       |

## PLATE XXXIV.

- Fig. 23. Fore wing pad of *Scolops* sp.  
 Fig. 24. Hind " " *Scolops* sp.  
 Fig. 25. Fore " " *Dictyophara* sp.  
 Fig. 26. Hind " " *Dictyophara* sp.  
 Fig. 27. Fore " " *Thionia simplex* Germ.  
 Fig. 28. Hind " " *Thionia simplex* Germ.

## PLATE XXXV.

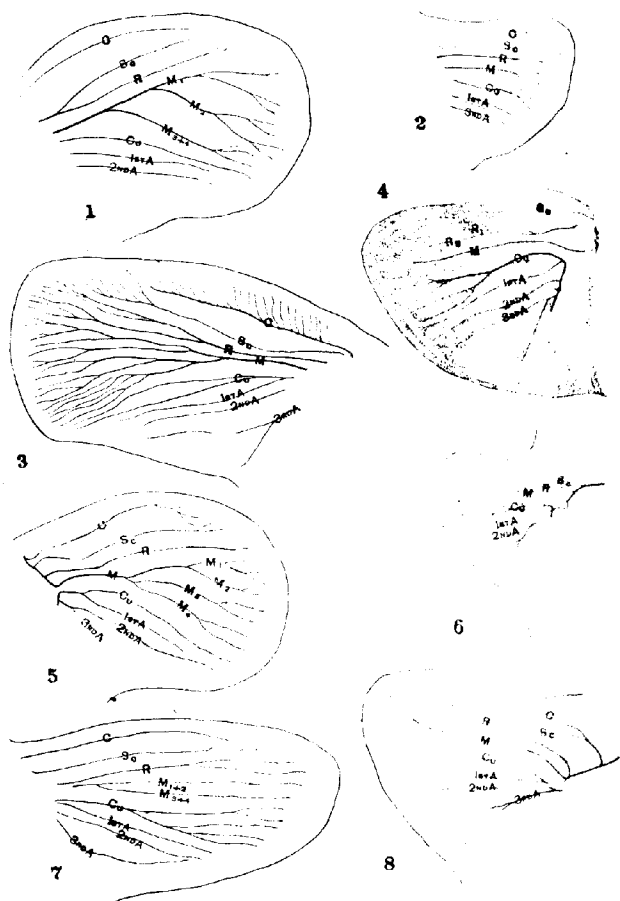
- Fig. 29. Fore wing of *Scolops pernix* Uhl.  
 Fig. 30. Hind " *Scolops pernix* Uhl.  
 Fig. 31. Fore " *Dictyophara florens* Stal.  
 Fig. 32. Hind " *Dictyophara florens* Stal.  
 Fig. 33. Fore " *Bruchomorpha oculata* Newm.  
 Fig. 34. Hind " *Bruchomorpha oculata* Newm.  
 Fig. 35. Fore " *Thionia bullata* Say.  
 Fig. 36. Hind " *Thionia bullata* Say.  
 Fig. 37. Fore " *Anotia* sp.  
 Fig. 38. Hind " *Anotia* sp.  
 Fig. 39. Fore " *Otiocerus coquebertii* Kirby.  
 Fig. 40. Hind " *Otiocerus coquebertii* Kirby.  
 Fig. 41. Fore " *Lamenia vulgaris* Fitch.  
 Fig. 42. Hind " *Lamenia vulgaris* Fitch.

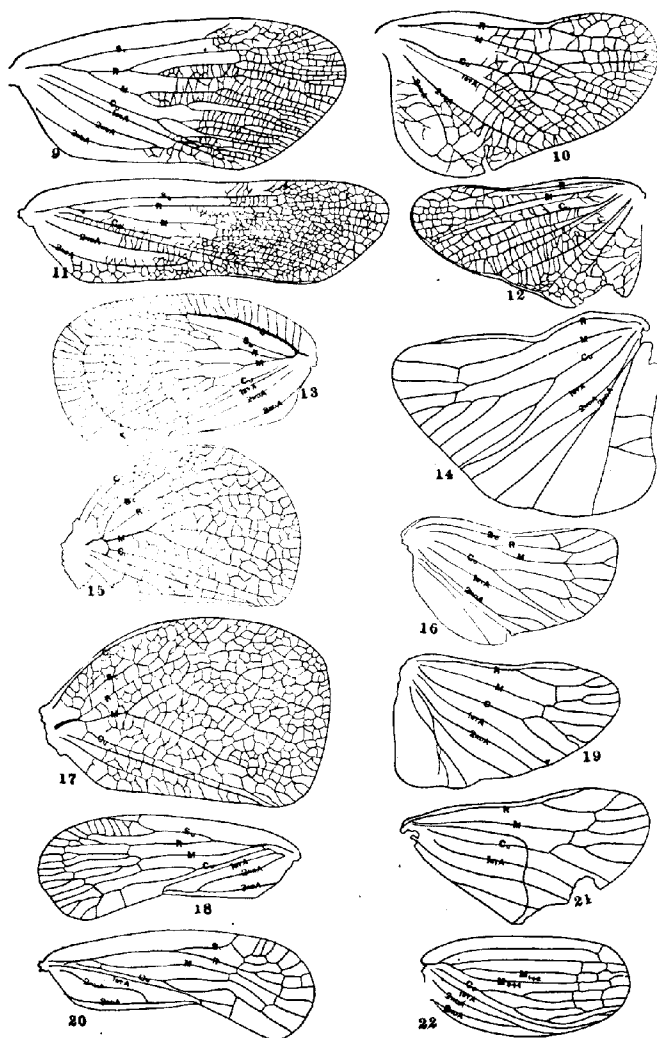
## PLATE XXXVI.

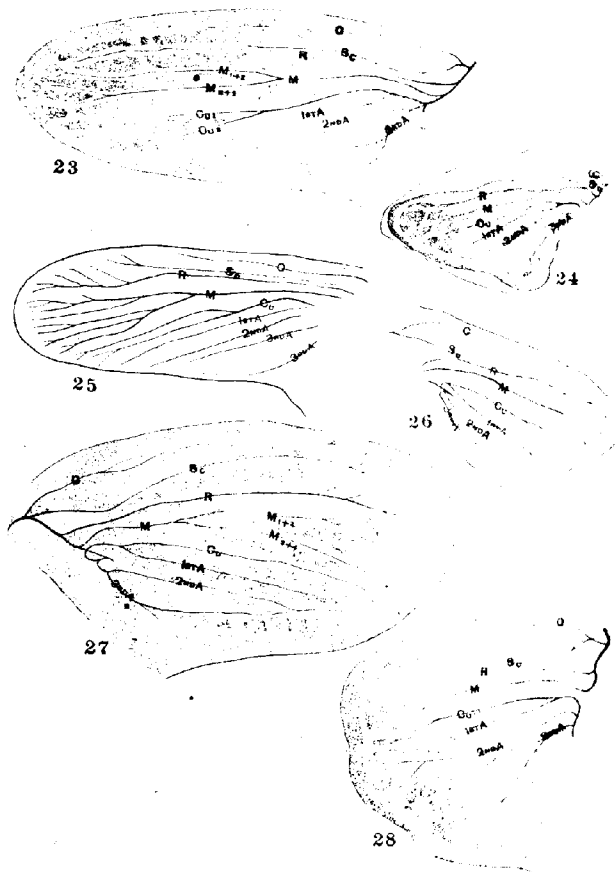
- Fig. 43. Fore wing pad of *Stenocranus* sp.  
 Fig. 44. Hind " " *Stenocranus* sp.  
 Fig. 45. Fore " " *Stobaera tricarinata* Say.  
 Fig. 46. Hind " " *Stobaera tricarinata* Say.  
 Fig. 47. Fore " " *Myndus radialis* Osb.  
 Fig. 48. Hind " " *Myndus radialis* Osb.

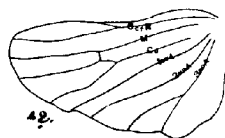
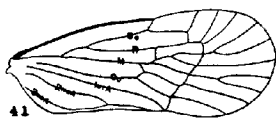
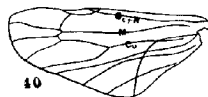
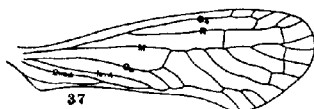
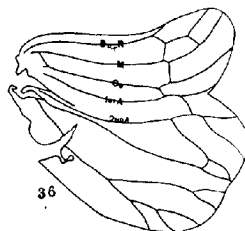
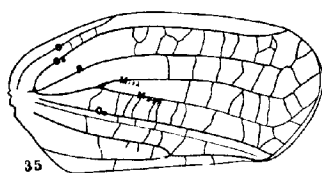
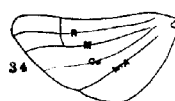
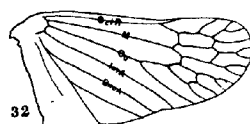
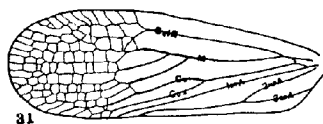
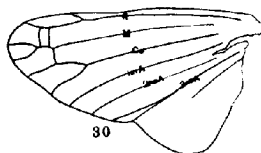
## PLATE XXXVII.

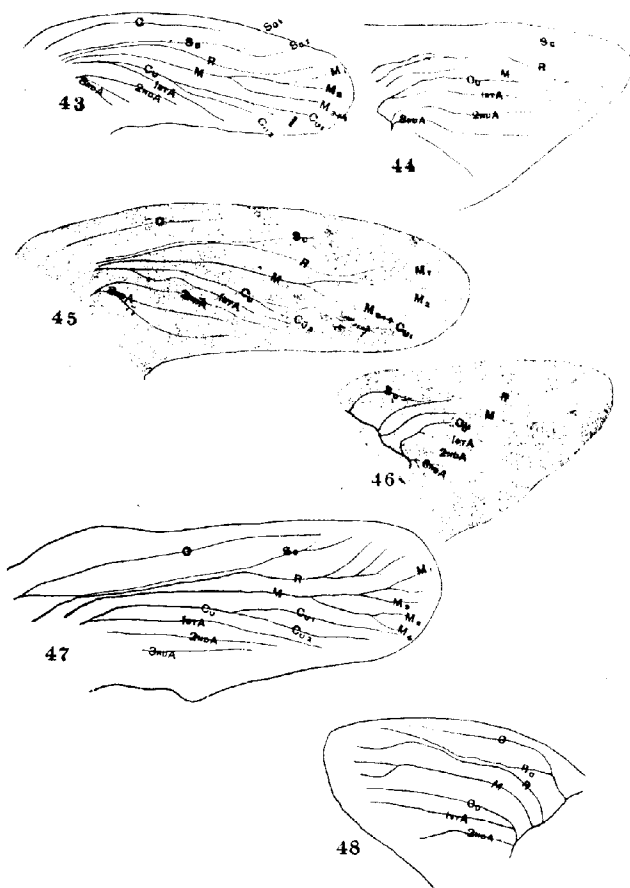
- Fig. 49. Fore wing of *Stenocranus lautus* V. D.  
 Fig. 50. Hind " *Stenocranus lautus* V. D.  
 Fig. 51. Fore " *Stobaera tricarinata* Say.  
 Fig. 52. Hind " *Stobaera tricarinata* Say.  
 Fig. 53. Fore " *Liburnia ornata* Stal.  
 Fig. 54. Hind " *Liburnia ornata* Stal.  
 Fig. 55. Fore " *Myndus* sp.  
 Fig. 56. Hind " *Myndus* sp.  
 Fig. 57. Fore " *Cixius* sp.  
 Fig. 58. Fore " *Oliarus 5-lineatus* Say.  
 Fig. 59. Hind " *Oliarus 5-lineatus* Say.  
 Fig. 60. Fore " *Bothriocera pro-signoretii*.  
 Fig. 61. Hind " *Bothriocera pro-signoretii*.  
 Fig. 62. Fore " *Æcleus decens* Stal.  
 Fig. 63. Hind " *Æcleus decens* Stal.



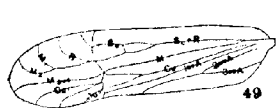








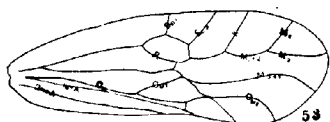




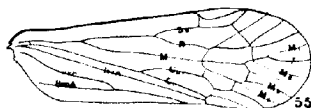
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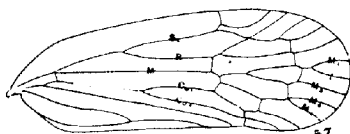
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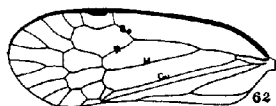
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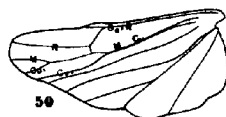
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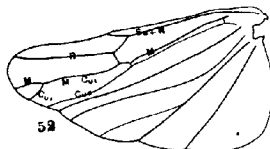
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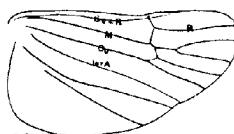
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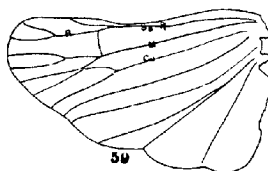
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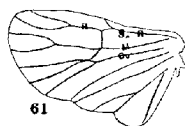
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59



61



63

## THE PRINCETON COLLECTION OF FOSSIL BEETLES FROM FLORISSANT.

By H. F. WICKHAM, Iowa City, Iowa.

Through the kindness of Professor Gilbert van Ingen, of the Department of Geology of Princeton University, I have been allowed to study the collection of Florissant fossil beetles in his care. The series is of particular interest since it forms a part of the material used by Scudder in working up two of his principal papers on the Tertiary insects\* and contains many of his types and cotypes. He studied the present collection with special reference to the Adephaga, Clavicornia and Rhynchophora and in these groups described practically all of the novelties which were in sufficiently good condition for that purpose. With the exception of *Atanius palescens*, for the determination of which I am responsible, all of the species attributed to his authorship in the following list were identified by him and the specimens represent the originals which served as the bases of his descriptions. Those attributed to myself are either lately published or now in press elsewhere. Ten are described as new. The drawings are made with a camera lucida and represent only what actually remains of the specimens, there being no attempt to restore lost parts or to idealize any of the characters.

As in all collections of fossil insects, a good many of the specimens are in too poor preservation to repay study, but it is possible to recognize the forty-two species listed below.

Carabidae.	Coccinellidae.
Bembidium tumulorum Scudd.	Coccinella sodoma n. sp.
Pterostichus walcotti Scudd.	Cryptophagidae.
Amara danæ Scudd.	Anthrophagus megabops n. sp.
sterilis Scudd.	Dermestidae.
Harpalus whitfieldii Scudd.	Dermestes tertiarus Wickh.
	Attagenus aboriginalis n. sp.
Staphylinidae.	Byrrhidae.
Staphylinus lesleyi Scudd.	Byrrhus romingeri Scudd.
Philonthus abavus Scudd.	Buprestidae.
Xantholinus tenebrarius Scudd.	Melanophila handlirschi Wickh.
Lithocharis scottii Scudd.	
Bledius morsei Scudd. (?)	
osborni Scudd.	

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\*Monographs of the United States Geological Survey, Vols. XXI and XL.

Lampyridæ.	Cistelidæ.
Podabrus wheeleri Wickh.	Cistela antiqua n. sp.
cupesoides Wickh.	Capnochroa senilis n. sp.
Telephorus humatus n. sp.	Rhynchitidæ.
Trypherus aboriginalis n. sp.	Paltorhynchus narwhal Scudd.
	Trypanorhynchus depratus Scudd.
Ptinidæ.	Otiiorhynchitidæ.
Xestobium (?) alutaceum n. sp.	Evopes occubatus Scudd.
Scarabæidæ.	Eudomus robustus Scudd.
Atenius patescens Scudd.	pinguis Scudd.
Aphodius aboriginalis Wickh.	Curculionidæ.
	Geralophus occultus Scudd.
Cerambycidæ.	fossicius Scudd. (?)
Callidiopsites grandiceps n. sp.	lassatus Scudd.
Leptura leidyi n. sp.	Cleonus primoris Scudd.
	Cremastorhynchus stabilis Scudd.
Chrysomelidæ.	Anthonomus arctus Scudd.
Crioceridea dubia Wickh.	Tychius evolatus Scudd.
	Aulobaris damnata Scudd.

### Coccinella Linn.

**C. sodoma** n. sp. (Plate II, Fig. 1). Outline subcircular, of the ordinary form of **Coccinella** if allowance be made for flattening. Sculpture extremely fine, consisting only of the alutaceous roughening common in the genus. Scutellum a little larger than in the recent North American species of **Coccinella**. Length, 7.75 mm.

Type in the Museum of Princeton University, number 6561.

An extended description seems unnecessary, since the figure will show the proportions of the different parts of the body. While it is safer to consider the generic reference as applying in the Linnæan sense, there is nothing about the specimen which would seem to throw it out of *Coccinella* proper. It is a little larger than the average *C. transversoguttata*, the common species of the Rocky Mountains today. No definite color pattern can be distinguished.

### Antherophagus Latr.

**A. megalops** n. sp. (Plate I, Fig. 1). Form subparallel and moderately elongate, the entire surface devoid of any distinct sculpture though there are faint signs of shallow, broad, elytral sulcations, a few small punctures towards the sides of the pronotum and what seem to be hair marks on the prothorax and elytra. Head large, about one and one-half times as long as the pronotum, slightly longer than wide, sides a little convergent anteriorly, front margin indistinctly preserved, but apparently about truncate. Eyes submedian in position, large and rounded, separated above by less than the width of one of them.

Antennæ submoniliform, slightly incrassate exteriorly, first joint large, second short, third longer than the fourth, though not much so, fourth to eighth subequal, the remaining three forming a weak club. The eleventh joint is damaged in this specimen, so that the exact form cannot be made out. Prothorax very short, about twice as broad as long, the form of the sides distorted, one appearing to be straight with the anterior angle distinct while the other is arcuate with the angles nearly obliterated. Scutellum absent or not defined. Elytra about one and one-half times as long as broad, apices, in life, probably conjointly rounding through as preserved they are separately sub-cuminate at tip. Legs wanting. Length, 4.30 mm.

Type in the Museum of Princeton University, obverse and reverse, numbers 6564 and 6535.

The head is larger than in the modern species of *Anthrophagus* that I know and the eyes are of much greater size in the fossil. It may be necessary, some day, to erect a new genus for this insect, but for the present, it seems better to allow it to remain in *Anthrophagus*.

#### *Dermestes* Linn.

*D. tertiarius* Wickh. (Plate II, Figs. 2 and 3). A specimen contained in this collection is in much more perfect condition than the type and shows a few additional features. The head is of normal size and punctured a little more strongly than the prothorax. The right antenna is displayed in sufficiently good preservation to show that it is very similar to that of the recent *D. marmoratus* except that the two joints immediately preceding the club are a trifle broader. The vestiture, punctuation and size are as described for the type.

On account of the imperfection of the type, which was used for the original figure, new drawings from the Princeton specimen are given herewith. The generic reference seems to be completely sustained by this example. It carries the Princeton Museum number 6613.

#### *Attagenus* Latr.

*A. aboriginalis* n. sp. (Plate II, Fig. 4). Form elongate, sub-elliptical. Head of moderate size, deeply inserted in the prothorax, minutely sparsely punctulate, eye rather small. Prothorax along middle a little less than one-half the basal width, sides arcuate, dissimilarly so in the specimen, front and hind angles well defined, apical emargination moderately deep, base rather strongly lobed at middle and sinuate each side, disk minutely punctulate or nearly smooth. Scutellum small, triangular. Elytra about three and three-fourths times the length of the prothoracic median line, not striate, punctuation minute, surface with signs of a fine hairy vestiture. Length, 5.00 mm.

Type in the Museum of Princeton University, number 6290.

The form, size, thoracic outline (especially the shape of the base), the proportions of the abdominal segments and the vestiture all point to this generic assignment. The sculpture seems to have been finer than that of any of the recent North American species with which I am acquainted, and this character will separate it from the fossil *A. sopitus*.

#### **Telephorus** Schöff.

**T. humatus** n. sp. (Plate I, Fig. 2). Form subparallel, rather narrow. Head crushed so as to appear excessively large, particularly since the basal antennal joints are thereby merged with the genae. Eye moderately large, rounded. Antennae equal to a little more than one-half the body length, first joint not distinguishable, second small, third shorter than the fourth, remainder subequal in length, all except the distal three with the inner angles produced so as to appear moderately serrate. Prothorax transverse, sides and apex rounded. Scutellum of normal size, triangular. Elytra four times the length of the prothoracic median line, rounded at apices. Legs rather short. Length, 7.50 mm.

Type in the Museum of Princeton University, number 5984.

In form and size this insect resembles the recent *T. bilineatus* quite closely. The sculpture is of the fine alutaceous type common in the genus.

#### **Trypherus** Lec.

**T. aboriginalis** n. sp. (Plate I, Fig. 3). Form similar to that of the recent **T. latipennis**. Head a little distorted, but evidently of moderate size. Antennae slender, filiform, the joints not serrate, but too poorly preserved to describe as to their relative lengths. Prothorax about as wide as the head, transverse, apex narrower than the base, sides moderately strongly rounded. Elytral length equal to twice the prothoracic width, apices narrowed, but rounded, sculpture strongly scabrous. Abdomen with several segments exposed beyond the elytral tips, without visible terminal appendages. Legs wanting, except one femur, which is rather slender. Length, 8.75 mm.

Type in the Museum of Princeton University, number 6527.

There is little doubt that this insect is closely allied to *Trypherus* if not an actual member of the genus. It has the size, form, sculpture and general appearance of the recent *T. latipennis*, common in the eastern half of North America.

The hind wings are spread and exposed, showing the basal portions of the venation quite well. A comparison of the figure of the fossil with the accompanying one of the wing of *T. latipennis* will show the close general correspondence between them. The dotted lines in the latter figure show as transparent markings on the general ground, but in the fossil the upper one of these is not visible while the lower one seems to have been strongly pigmented.

**Xestobium** Motsch.

**X. (?) alutaceum** n. sp. (Plate I, Fig. 5). Form not very elongate. Head large, deflexed, eye about circular and rather small compared with that of most recent Anobiini. Pronotum somewhat gibbous dorsally at about the middle, projecting anteriorly over the head. Elytron with a rather weak epipleural lobe within which is a fine but distinct stria, apex apparently rounded. Legs short and only moderately stout. Length, from front of pronotum to abdominal apex, 6.65 mm.

Type in the Museum of Princeton University, number 6575.

In a general way, this species slightly resembles the Florissant fossil *Xylobiops lacustre*, but the proportions are different and the sculpture of the present species is very fine. The entire upper surface shows traces of a minute scabrosity, but the abdomen is almost entirely smooth. The elytra are not striate except inside the epipleural margin. By the small eyes, the size, sculpture and general form, this seems to approach *Xestobium*, but the generic reference must be considered provisional, the most dubious character being the large head.

**Callidiopsites** n. gen.

This generic name is proposed for a Cerambycid fossil which shows affinities with *Callidium* in the broad short form, short stout antennæ, heavy legs, transverse and nearly or quite confluent front coxal cavities, and coarse elytral sculpture. It differs in the mesosternum, being much narrower between the middle coxæ and the head very much larger. It is not entirely in agreement with any of the recent genera of Callidioides known to me and it seems better to give it a separate generic assignment. The type is *C. grandiceps*, described below.

*C. grandiceps* n. sp. (Plate III). Form rather short and stout, outline, as preserved, not unlike some species of *Patrobis* in the Carabidae. Head large, nearly as long as broad and decidedly longer than the prothorax. Eyes not definable. Antennae extending a little beyond elytral two-thirds, moderately stout, the first joint large and thick, third not greatly elongate, tenth and eleventh distinctly shorter than the two preceding. The joints are apparently carinate along their faces. Prothorax very short, a little wider than the head. Elytra (likely enough from abdominal distention due to maceration) not completely covering the dorsal segments, their apices separately rounded, surface coarsely closely punctured with some indication of striae at the outer margins. Thighs heavy, somewhat clavate, especially the middle and hind pairs. Apex of abdomen extruded, displaying a simple, straight sex organ. Length, to extended tip of abdomen, 15.25 mm.; of elytra, 8.25 mm.

Station number 13B. One specimen, collector not specified, was received from Professor Cockerell. The type is in the Museum of the University of Colorado. Another is contained in the Princeton collection, with the number 6543.

This looks like a Carabid, but what can be seen of the structure of the underside together with the large antennae incline to the assignment given above. The antenna figured is a trifle too slender, since it is a camera lucida drawing and the edges of the organ were not entirely freed from the matrix.

#### *Leptura* Serv.

*L. leidy* n. sp. (Plate I, Fig. 6). Form, judging from the remains, subparallel, as in the recent *L. sphaericollis*. Head apparently incomplete in front of the eye, which is reniform, distinctly emarginate and of rather small size. Antennae not preserved, except a few of the basal joints which are relatively shorter than usual in the living forms. Prothorax a little damaged, but apparently not strongly campanulate. Elytra subparallel to apices which are separately rounded and not much narrowed. Surface sculpture everywhere very fine, the elytra seemingly with a delicate pubescence. Legs moderately long. Length, from front of head to abdominal apex, 7.50 mm.

Type in the Museum of Princeton University, number 6512.

The small size will at once separate this from any of the other described species of Florissant *Lepturae*, and the fine sculpture serves to differentiate it from *L. antecurrens* which comes nearest in length. Like the other fossils from Florissant ascribed to this genus, it must be considered a *Leptura* in the wide sense only. It is named after Joseph Leidy, zoologist and palaeontologist.

*Cistela* Fabr.

*C. antiqua* n. sp. (Plate IV). Form fairly stout. Head finely rather densely punctulate and hairy. Eyes, as shown by their sockets, moderately large. Antennæ slender, the basal two joints not definable, the remainder sub-equal, scarcely serrate, the distal ones not incrassate; if directed backwards, the antennæ would reach nearly to the basal fourth of the elytra. Prothorax broad at base, narrowed at apex, sides gently arcuate, surface finely punctulate and hairy like the head, but more distinctly. Scutellum of moderate size, sculptured like the thorax. Elytra not alike in outline on account of the specimen being crushed askew, but the left one, which seems to be the better preserved, is a little more than four times the length of the prothoracic median line, tapering to the rather sharply rounded apex. Elytral sculpture and vestiture like that of the pronotum. Legs wanting. Length, from front of head to elytral apex, 13.10 mm.

Type in the Museum of Princeton University, number 6534.

The appearance of this insect is that of a *Cistela* with estriate elytra and slender antennæ. Compared with the North American species known to me, it comes closest to *C. pinguis* from Colorado. It is about the size of the fossil *Capnochroa senilis*, but that insect has striatopunctate elytra.

*Capnochroa* Lec.

*C. senilis* n. sp. (Plate II, Fig. 5). Form elongate, subparallel as far as shown, but the elytral apices are broken off. Head rather large for this genus, transversely finely subrugose. Eyes, as displayed, transversely elliptical and of good size. Palpus (probably the maxillary) with the terminal joint roughly triangular, moderately dilated. Antennæ relatively less elongate than in the recent *C. fuliginosa*, not serrate, second joint shorter than the third, which is not so long as the fourth. Prothorax narrowed anteriorly, the more perfect side about straight, anterior coxæ narrowly separated by the prosternum. Scutellum of moderate size. Elytra long, if complete they would be about six and one-half times the median prothoracic length, rather coarsely striate and punctate. Legs moderate or rather short, not excessively slender, the tarsi, as far as shown, a little shorter than the tibiae, claws large, the front ones apparently pectinate. Length of fragment, 12.40 mm.; if entire, the insect would reach about 14.00 mm.

Type in the Museum of Princeton University, number 6902.

While the generic reference must be considered somewhat doubtful, it seems safe to assume that the fossil represents a large *Cistelid* belonging in the same neighborhood as *Capnochroa*. The texture is very like that of the *Cistelidæ*, the



prosternum being strikingly like that of *Capnochroa* and setting up strongly in the same way. The arrangement of the coxæ is as in that genus and the front tarsi correspond very well. The form of the palpus is similar. Under high power, the claws show transverse markings, which I think are the somewhat obscured pectinations. The strength of the elytral sculpture is indicated by its showing through, although the specimen is preserved as an underside. A disturbing element is introduced by the antennæ, which are shorter and less serrate than in the modern species, but I dislike to found a new genus upon this character alone. Our living *Capnochroa fuliginosa* occurs in the Atlantic district and as far west as the Mississippi Valley.

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EXPLANATION OF PLATES.

PLATE I.

- Fig. 1. *Antherophagus megalops* n. sp.  
Fig. 2. *Telephorus humatus* n. sp.  
Fig. 3. *Trypherus aboriginalis* n. sp.  
Fig. 4. *Trypherus latipennis*, (recent), hind wing.  
Fig. 5. *Xestobium* (?) *alutaceum* n. sp.  
Fig. 6. *Leptura leidy* n. sp.

PLATE II.

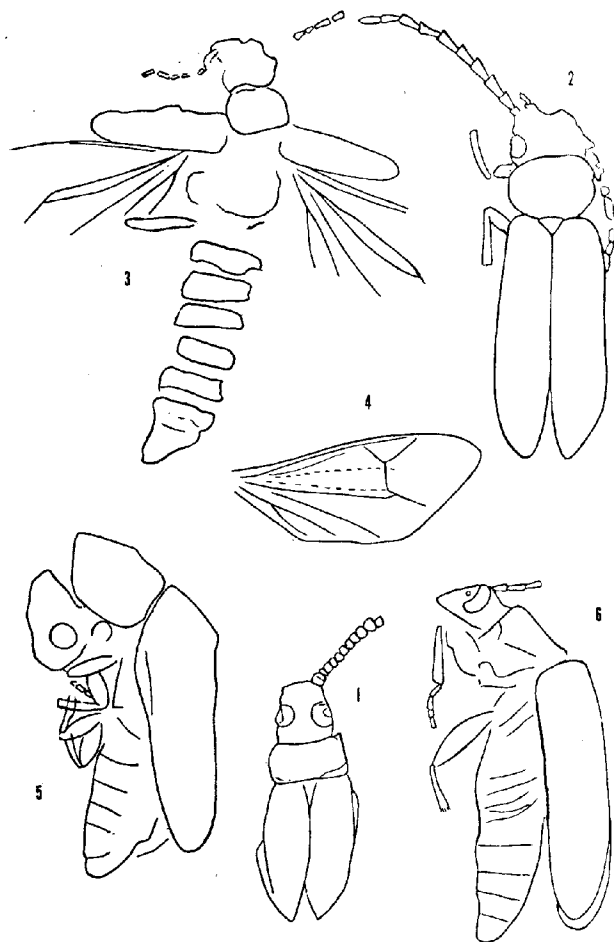
- Fig. 1. *Coccinella sodoma* n. sp.  
Fig. 2. *Dermestes tertiarius* Wickh.  
Fig. 3. *Dermestes tertiarius*, antenna.  
Fig. 4. *Attagenus aboriginalis* n. sp.  
Fig. 5. *Capnochroa senilis* n. sp.

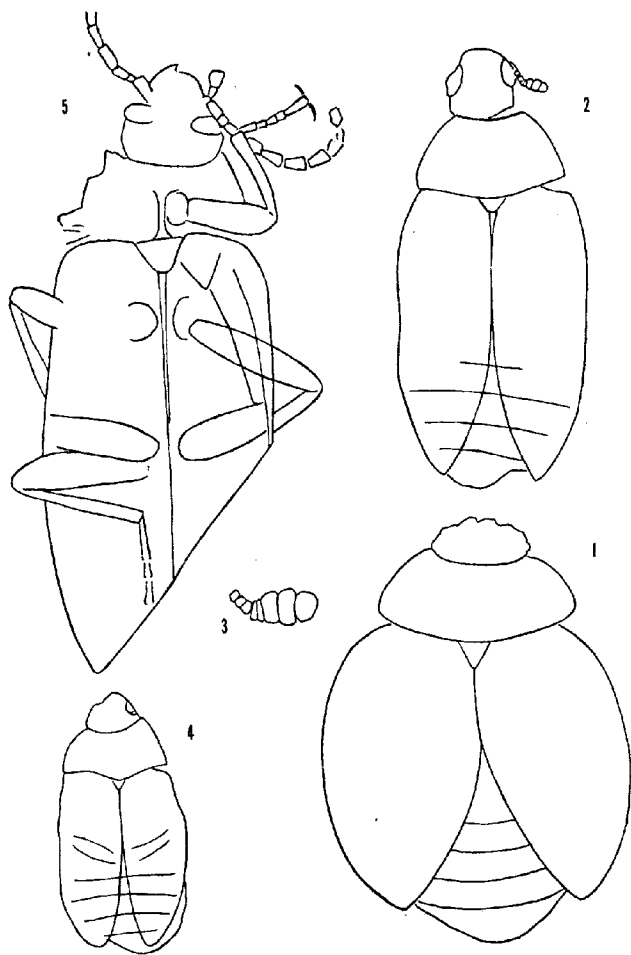
PLATE III.

- Callidiopsites grandiceps* n. sp.

PLATE IV.

- Cistela antiqua* n. sp.









*H. F. Wickham.*

# A CONTRIBUTION TO THE BIOLOGY OF MAY-FLIES.\*

ANNA H. MORGAN.

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## I. INTRODUCTION.

This is a study of the habits and structure of May-flies. It describes the situations in which they live and some of the adjustments which they have made to the conditions in them. The two problems which face every organism are those of maintaining its own life and continuing its race. Its youth is devoted entirely to satisfying its individual needs for food and safety; its adult life is devoted to the race, but the necessities of the individual are still satisfied though they may be secured in an entirely different way. The immature life of May-flies is aquatic, and to it all adjustments concerned with food or safety are exclusively confined. The mature or adult life is aerial. It is solely devoted to reproduction. There is no provision for food or for other means of lengthening its life. It gives an opportunity for studying ways of getting a living which have been completely isolated from ways of reproducing. The study which follows has been divided into five sections.

1. The historical sketch, in which the more important papers which have dealt with May-fly biology are briefly discussed.

2. The life cycle which consists of a brief statement of the characteristics of the three stages of life.

3. The evolution of the nymphs in which progress from a generalized to a specialized condition is shown in changes of shape and function of gills, mouthparts, and legs.

\*Contribution from the Limnological Laboratory of Cornell University. This work was done under the direction of Professor James G. Needham, of whose kindly criticism and stimulating interest I wish to express my appreciation. I wish also to thank Miss Anna C. Stryke for her many helpful suggestions regarding the drawings and the photographs from which some of the drawings have been taken.

4. The evolution of the adult in which specialization is shown by changes of function and developments for the furtherance of reproduction.

5. Adjustments for aquatic situations shown in the structures of the eggs.

6. A Bibliography of biological, morphological, and the more important systematic works dealing with this group.

## II. HISTORICAL.

In the following historical sketch I have tried to select the more important papers of biological significance. In many cases, however, systematic, morphological, and biological work have been so closely related that such a separation has been impossible.

*Swammerdam*. 1661. The foundation study of the biology of May-flies was made by Johann Swammerdam, at Culenburg, on the Rhine, in 1661. As a field naturalist, he learned the most important facts concerning the life of *Ephemerus*, (probably *Palingenia longicauda* Oliv.). As an anatomist he dissected and studied its internal and external structure with great care. He described the emergence of the nymph, the sub-imago stage in males, and the final or imago stage in which he believed that the eggs and the sperm were deposited separately in the water. He concluded that no food was taken during aerial life, and that copulation did not occur. He examined the eggs and tested their power of dispersal by letting them fall into the water from the end of a knife. His work is a remarkably truthful and interesting record. Later works have added and corrected, but none have contributed better biology.

*Reaumur*. 1742. In *Memoires des Insectes*, 1742, Reaumur reviewed much which had already been told by Swammerdam, and illustrated more profusely the life history of a burrowing May-fly, probably also *Palingenia*. Some of Reaumur's observations were made upon nocturnal species. After he had noticed them swarming about a light near the river bank, he placed a tub of water in his own garden. By holding a light above this, in the evening, he was able to gather great numbers of May-flies and to watch their transformation from the sub-imago to the imago stage, and to see them lay their

eggs in the water. He counted the eggs which he found protruding from the abdomens and determined the average number to be 750 to 800 for each female. He disagreed with Swammerdam regarding the fertilization of the eggs, and stated that the males and females probably did mate, and that the forceps of the male were evidently for the purpose of seizing the female.

*DeGeer*. 1748. In 1748 DeGeer saw the mating\* actually take place. Two years later he again saw the mating flight and the mating, and this time was able to give more facts concerning it. The swarm consisted mostly of males. In mating the male was beneath the female with his abdomen recurved upward so that its tip rested against the two openings of the oviducts, between the eighth and ninth segments. Copulation lasted but an instant, and De Geer was not able to observe the process in detail. He described several different varieties of May-flies, distinguishing them by descriptive color names. The double eyes of a diurnal May-fly (possibly a *Leptophlebia*) were mentioned, the larger eyes being named the turbinate eyes.†

*Geoffroy*. 1764. Geoffroy, 1764, saw great swarms of May-flies near Paris and noted that there they were called "manne de poissons," because great numbers fell down into the streams to the fishes. He accurately figured and described as a Crustacean,‡ the May-fly, later determined by Vayssiere as *Protopistoma*, which he found in the riffles of a stream near Paris.

*Newman*, 1836. In discussing the transformations of insects, Newman, 1836, wrote of May-flies as follows: "Here then we have the strange fact of an insect's flying before it reaches the imago; that is, flying in the penultimate state. It thus appears that although until the final ecdysis, no insect arrives at perfection; yet before that period, even in the state immediately preceding, it may feed, run and even fly; or it may swim, crawl, barely move, or be without motion."

*Bowerbank*, 1833. Bowerbank studied the circulation of the blood in young nymphs of *Ephemera marginata*. He carefully examined the dorsal vessel with its valves and described the circulation of the blood. He was the first to see

\*DeGeer, 1748, T. II, p. 644.

†DeGeer, 1748, T. II, p. 651.

‡Geoffroy, Tom. II, p. 658. "Le Binnocle a queue en plumet."



in the setæ the two currents of blood which have since been carefully studied.

*Westwood*, 1840. In 1840 Westwood discussed the classification of May-flies, following the discussion with some biological facts mostly gathered from previous writers.

*Burmeister*, 1848. Burmeister made the first real contribution to May-fly embryology. While sitting in his room one evening, many females of *Palingenia horaria* flew through the open window and began depositing eggs upon his table. Burmeister described these eggs and figured them. He placed some of them in water on July 22 and on August 2 he freed an embryo from the shell. He studied this stage carefully and figured it showing the mouth-parts, legs and gills.

*Leuckart*, 1858. Ten years later Leuckart carefully described the eggs of three May-flies. This work was followed by

*Grenacher*, 1868. Grenacher's short, but important paper, "Beitrage zu Kenntniss des Eies der Ephemeriden." He studied eggs similar to those cited by Leuckart and showed that the polar knobs described by him were to be found in various stages within the ovary. So far as known, Leuckart and Grenacher have been the only authors who have made any careful study of these egg structures in May-flies.

*Pictet*, 1843. The first general study of this group was the monograph in the "Historie Naturelles des Insectes Neuropteres" by Pictet. He classified preceding biological and systematic studies and gave a history of each, reviewing all of the most important contributions from Aristotle to 1840. He described the habits of his four classes of nymphs, fossorial, flattened, swimming and crawling. He discussed the emergence of the nymph and features of the sub-imago and imago stages, but he gave many details less satisfactorily than Swammerdam or Geoffroy.

*Dufour*, 1849. In 1849 Leon Dufour published a memoire on the different kinds of respiration in insects. In this he classified May-flies with insects breathing by means of external organs. This study was followed by the similar ones of Mueller, 1851, and Milne Edwards, 1857.

*Lubbock*, 1863-6. After the first contribution to May-fly embryology by Burmeister in 1848, no further investigations were made until 1863-6, when Sir John Lubbock published two papers, "On the Development of *Chloeon dimidiatum*."

In these two studies he followed individuals through twenty-three successive moults, tracing them to the adult stage. He did not, however, begin his observations at the actual time of hatching as Burmeister had done.

*Hagen*, 1849-1890. The foundation for the study of May-flies in North America was made largely through the inspiration and contributions of Prof. Hermann Hagen. Although the greater part of his work was systematic, the notes which he sent to Eaton in 1873 show that he made valuable additions to the knowledge of their biology. Hagen identified the nymph of *Baetisca* which B. D. Walsh described in 1864.

*Walsh*, 1864. Walsh concluded his paper on *Baetisca* with a description of the swimming habits of the nymphs which he kept for some time under observation.

*Eaton*, 1870. About the end of 1870, Rev. A. E. Eaton submitted to the Entomological Society of London the most important work done upon the group since Pictet's monograph. In 1883-86, the completed work was published in the Transactions of the Linnean Society.

*Eaton*, 1883. In this work the world fauna was reclassified and a great number of forms were described and figured with such accuracy that it at once became and has remained the most important work upon the order. The introduction contained a general account of the biology which included several of Dr. Hagen's\* field notes.

*N. Joly*, 1876. Joly, '76, studied the embryology of *Pal-ingenia virgo*. He kept eggs in dishes of water and recorded the structures of the developing embryo on the 5th and 6th day. This work was followed by another by N. and E. Joly, which dealt mostly with the structure of the systems in the nymphal and imago stages of certain species.

*Vayssiere*, 1882. Vayssiere published the first extensive study of the nymphs. This paper was written almost entirely from a morphological view point, but it contains many references to short biological papers.

The papers of Zimmerman, '79, Eaton, Hagen, Joly, Palmer, '83, Creutzburg, '85, and others were mainly morphological.

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\*1873. Hagen Notes on the Ephemeridæ. Compiled by Eaton.

*Fritze*, 1889. *Fritze*, '89, studied the structure of the alimentary canal. He described and figured a muscular apparatus in the oesophagus, and discussed its changes of function in the adult.

*Heymons*, 1896. In a paper upon the embryology of *Ephemera vulgata*, *Heymons*, '96, stated that the eggs hatched eleven days after they were laid. He traced the development of the nymphs up to the age of four days. He discussed the ancestry of May-flies, and concluded that their life was originally entirely aerial and that the closed tracheal system of the nymphs is an accommodation to aquatic life.

*Causard*, 1896. *Causard* noted the birth of living young in *Ephemera vivipara* and briefly described the development of the nymphs.

*Hubner*, 1902. *Hubner*, '02, tested the regenerative powers of nymphs of *Clocon dipterum*. Certain nymphs regenerated the last abdominal segment with its appendages. The alimentary canal became functional, and the insect lived for one month.

*Tumpel*, *Needham* and *Betten*, 1901. In the same year two general papers were published. "Die Geradflügler Mitteleuropas" by *Tumpel* and several complete life histories in "Aquatic Insects of the Adirondacks" by *Needham* and *Betten*.

A similar but much more extensive work by *Needham* followed in 1905 and 1908. In the introduction to this study May-fly nymphs were described as "perhaps the dominant insect herbivores of fresh water." Their herbivorous diet and their importance in the economy of aquatic life were for the first time emphasized.

*Sternfeld*, '07. *Sternfeld*, '07, worked upon the atrophy of the mouth-parts and the changes in function of the alimentary canal. He reviewed *Fritze's* paper and considered the biological significance of the structures much more fully. He concluded that the alimentary canal in imago May-flies is by no means rudimentary and that a muscular apparatus, which is under voluntary control, regulates the supply of air in it. The decrease of specific gravity caused by this "swimming bladder" aids the insects in the mating flight and hence indirectly influences their multiplication.

*Drenkelfort*, '10. Drenkelfort wrote a general account of the biology of *Siphilurus lacustris*.

*Wodsdalek*, '11. Wodsdalek experimented upon nymphs of *Heptagenia interpunctata* Say and found that they were repelled by light, but that these reactions could be reversed by the addition of certain chemicals to the water.

### III. LIFE CYCLE.

The life cycle of May-flies includes the embryonic period within the egg, and the active life which is divided into nymphal, sub-imago and imago stages.

Almost the earliest studies of the embryos were made by Burmeister, '48, who described those of *Palingenia horaria* twelve days after laying. He noted the rudiments of the mouth parts and legs. According to Joly, '76, embryos of *Palingenia virgo* take about two months for development. Heymons, '96, found that eggs of *Ephemera vulgata* kept in a temperature of 20-25 C would hatch in ten to eleven days. At hatching they measured 1 mm. with setæ inclusive. The antennæ and setæ were respectively five and four segmented. External gills were not yet present, but all of the systems were complete except the reproductive. On segments two to seven of the abdomen was a series of lateral hypodermal thickenings. Heymons believed that the gills which arouse four days later were outpushings of these thickenings. He held the gills to be lateral projections homologous with the legs and not of dorsal origin as often considered. From the structures in the embryo he concluded that a homology between gills and wings is unfounded.

By nymphal stage is meant the period of life between hatching and emergence from the water. The exact limits of its duration are unknown. Lubbock, '66, followed a *Chlocon dimidiatum* through twenty-three moults to the imago stage, but his data does not begin at time of hatching. *Hexagenia variabilis* lays its eggs in April and May, but I have found large and small nymphs abundant in the same locality in the March preceding, so that they must require at least two years to mature. Nymphs of *Callibaetis fluctuans* mature in about six weeks in mid-summer. As already noted, May-flies quit the egg in a fairly advanced state of development. They

are very active and nearly all are voracious herbivores. The nymphal period is one of extreme competition and during it the nymph must find safety, and get food sufficient for its entire life. With the exception of the Diptera, May-flies are the dominant aquatic insect herbivores. They have attained this position by utilization of a vegetable diet and by remarkable adjustments to particular situations. The population about them is divided into two classes, competitors and enemies. Their competitors are mostly insects, which, like the May-flies, live upon herbivorous or nearly herbivorous diet; among them are the larvæ of Caddis-flies (except the Hydrosychidæ), Crane-flies and most of the smaller Diptera. Their enemies are wholly or in part carnivorous. Important among them are the nymphs of Dragon-flies, Stone-flies, many beetles and the Hemiptera and Neuroptera. The adolescence of the nymph is evidenced internally by the development of the reproductive organs, and externally by the growth of rudimentary wings. This stage is terminated by a gradual change in organs of locomotion, respiration and digestion and by the final casting off of the nymphal skin.

The first winged or aerial stage is known as the sub-imago. The general form of body differs little from that of the actual adult insect. The wings are fully expanded and direct respiration through open spiracles is established. All surfaces are dull and in most cases the wings have a prominent marginal fringe of hairs. A few May-flies (females of *Palingenia* and *Campsurus*, Eaton '83) never lose the sub-imago skin, but in nearly all it is shed. The duration of the sub-imago stage varies from a few minutes in the most ephemereal species to several days. Needham,\* '08, has given this account of *Caenis diminuta*. "It is the most ephemeral of all Ephemera. It emerges from the water at nightfall, leaving its nymphal skin floating on the surface, and, alighting on the first support that offers, sheds its skin again, and the sub-imago stage is ended."

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\*N. Y. State Bull. 124, p. 178.

The following data upon some of the longer lived species shows its average length:

Heptagenia interpunctata	♂	2	days = length of sub-imago life			
"	"	♂	1	" =	"	"
"	"	♀	1	" =	"	"
"	"	♀	1	" =	"	"
Siphilurus alternatus		♀	2	" =	"	"
"	"	♂	2	" =	"	"
Iron fragilis		♂	2	" =	"	"
"	"	♂ ♀	2	" =	"	"
"	"	♂ ♀	2	" =	"	"

Sub-imagos are very inactive and in nature spend the day-time resting in the shade, often upon the under side of leaves near the stream from whence they emerged. In captivity they are just as inactive, but if confined in very narrow quarters, they almost invariably fail to transform successfully. During this stage the legs, especially the front ones, and setæ are elongated and the reproductive system matures.

That this sub-imago stage is peculiar to May-flies is a well known fact. Little light, however, has been thrown upon its actual significance and analogy to the stages of other orders. Boas, '99, suggested that the sub-imago stage once had a wide distribution among Orthoptera which have now died out; that this corresponds to the pupal stage of holometabolous insects; and that the Ephemeridæ show a transition toward perfect metamorphosis. He believed that there was nothing in the form of Neuropterous pupæ which contradicts the theory that they have been developed out of such sub-imago stage.

The single molt of aerial life is followed by the mature or imago stage. At the beginning of this stage the eyes, legs and setæ attain full size. All surfaces of the body are shiny and the wings are transparent. The duration of this, like the sub-imago stage, varies greatly with the species. It varies also with the individual. Males which have mated are said to live a much shorter time than those kept in captivity.

Imagos are usually active at special times. Those of diurnal species fly freely at all hours of the day, but oftenest are seen in mating flights during the late afternoon. The nocturnal

May-flies must swarm in like manner at night is testified by the great numbers often caught in webs in the early morning. The important functions of this stage are the fertilization and laying of the eggs.

#### IV. MODIFICATIONS OF STRUCTURES OF THE NYMPH.

Nymphs of Ephemerinæ and Heptageninæ (Needham) live fairly within the limits of two ecological situations. The Ephemerinæ inhabit mud or muddy water exclusively. Most of the Heptageninæ live in riffles of streams or upon the wave washed shores of lakes. The Bætinæ inhabit gentle currents or open waters and intermingle with the mud and cascade dwellers as well. They have become adjusted to very different situations and they show a wide range of specialization.

All of the Ephemerinæ which have been found here live in the same situation and are very similar in their habit of life. Ephemera and Hexagenia are true burrowers in the mud; Polymita occasionally adopts the digging habit and Potamanthus crawls upon silt covered stones and muddy bottoms in the same locality.

The members of the Heptageninæ are also very homogeneous habit. They live in running water, clinging or moving about upon the under sides of stones. Iron and Epeorus dwell in the swiftest water of the current, in riffles and falls; Ecdyurus and Heptagenia live in the gentle currents along the borders of the stream and sometimes beneath the stones in quiet pools.

The Bætinæ dwell in a variety of situations. Siphurus and Callibaetis clamber upon the aquatic plants or dart about on the alga covered bottoms of still pools and inlets, while Ameletus more often frequents moving waters and nymphs of Blasturus hide among decayed leaves in ponds and brooks. Leptophlebia and Habrophlebia cling closely to the surface of stones, usually upon the under side and often in fairly rapid water. Most members of the genus Ephemerella have a similar habit, but there is a wide divergence among the species of this genus. Two genera, Baetis and Chironomus, are dwellers in water falls, and the latter has become remarkably well adjusted to its habitat. Tricorythus and Caenis are adjusted to life in mud and sand and show structures especially well fitted to their surroundings. These two extremes of

specialization are examples which show the variety of adjustments within this family. As later discussions will point out, they also show what diverse structures may fit an organism equally well for life in the same of similar situations.

Since the outside of an animal is the first to be influenced by environment, the most important adjustments must be looked for in external structures. In this study only the three most important sets will be considered; those which have to do with respiration, food and motion.

#### SHAPE OF BODY IN THREE SUBFAMILIES OF MAY-FLIES.

Before attempting to trace the adaption in the three systems just named, it is necessary to briefly describe the general shape of the nymphs in the three subfamilies.

The bodies of the Ephemerinae are elongate, more or less cylindrical and tapering at either end. Those of Ephemera (Pl. XLIV, Fig. 8) and Hæxagenia are almost perfectly cylindrical. The heads are wedge-shaped with the mandibular tusks projecting sharply in front. The bodies of Polymitaereys and Potamanthus (Pl. XLIV, Fig. 7) are flattened. The head of the latter is short and broad with the mandibular tusks barely showing beyond the labrum. A comparison of Ephemera (Plate XLIV, Fig. 8), with Potamanthus, will immediately show Ephemera to be the burrower.

In the Heptageninae, the head, the body and all its appendages are depressed. In Iron and Epeorus (Pl. XLII, Fig. 4), which inhabit the swiftest water, this depression is greatest, but in Heptagenia and Ecdyurus, it is also very pronounced.

The form of the Bætinæ is various. The most representative is the slender compressed body and rather small rounded head which is characteristic of the active nymphs like Callibaetis, Ameletus, (Pl. XLIII, Fig. 5 and Pl. XLII, Fig. 3). All of these nymphs have long legs for running and jumping, but in another type, the body is shortened, more or less flat upon the ventral side, and thickened through the metathorax. Such a form is represented by the majority of the Ephemerellas. It is most marked in the very short stubby bodies of Canis and Tricorythus, which have become exclusively mud dwellers. In Blasturus (Pl. XLII, Fig. 1) there is a tendency to a depressed form. This is more pronounced in Choroterpes, which is strikingly similar to the Heptageninae.



ADJUSTMENT TO ENVIRONMENT SHOWN IN THE STRUCTURE OF  
THE GILLS.

The gills of May-flies are especially susceptible to modification by the character of their surroundings. They are usually large and prominent. In other aquatic insects gills are less directly exposed. Those of stone-flies are generally tucked behind the legs upon the ventral side of the thorax, and those of damsel flies at the hind end of the body. Most May-flies have seven pairs of gills, one borne at each postero-lateral angle of the first seven tergites. They are usually large, sometimes unweildy and always a conspicuous feature of the body. Situated as they are, they extend along the whole side of the abdomen and brush against everything with which it comes in contact.

The gills of *Leptophlebia* are the most generalized of any which have been examined. They appear to lack modifications both for respiration in any particular situation or for protection. The seven pairs are identical in shape and nearly so in size. Each one is entire at the base, but deeply cleft into two long narrow divisions which lie in one plane. Their surfaces are without markings or local thickenings. One large trachea enters the gill and sends a branch to each of its divisions. In these there is but a scanty supply of tracheoles. The attachment to the abdomen is exposed above and below so that the only protection for the gill is in the ease with which it may be detached and regenerated.

In *Blasturus* the first pair of gills are like those of *Leptophlebia*, but the other six pairs are broadened so that a much greater respiring surface is provided. At the base a trachea enters and splits once, but each arm gives off a good number of branches which supply the whole surface of each gill division or lamella. The two lamellæ do not lie in the same plane, but the outer one is twisted over at the base and lies on top of the inner. A double gill made of two overlapping lamellæ is thus formed. A variation of this same kind of development is shown in the gills of *Choroterpes*. These gills have neither ribs, nor bands upon their margins. In consequence of this they hang limply from the sides of the body, but the main tracheæ provide some leverage for the muscles, and the gills

can be moved a little. The breathing movement is, however, slow and feeble. The nymphs are thus provided with large breathing organs, but also burdened with an unwieldy load.

In *Siphilurus* the gills are double and are stiffened by strong tracheæ and moved by muscles at the base, so that they can be held upright and can also be vibrated with great rapidity. In addition there are narrow spinous bands upon the inner sides of the upper lamellæ. Those of *Callibaetis* (Pl. XLIII, Fig. 5), are held in upright position, and can be rapidly vibrated like those of *Siphilurus*. They are much smaller and lie farther dorsad when pulled down close to the body. They are better protected because less conspicuous, and better breathing organs because their rapid vibration enables them to absorb as much oxygen as if they were broad and bulky.

In the gills of *Baetis* the marginal bands are hardly indicated, but those of *Ameletus* are broadly bordered by thick spinous bands of chitin. In them the single lamella is fairly supplied by tracheæ. Its base is inserted into a shallow notch in the posterior margin of the tergite. Its attachment is thus slightly protected and at the same time it is allowed to swing freely. Adjustment to the conditions in water falls is always marked by an increase in the tracheal supply. In *Chironetetes* (Pl. XLVI, Fig. 13), this has been made by a great increase in the number of fine tracheoles which supply the lamella and by the development of a fimbriate gill at the base main trachea of which is a branch of the main trachea of the lamella. The margins of the lamella are bordered with thickened spinous bands similar to those of *Ameletus*, but it has also a stiff rib extending from base to tip.

A second group of *Baetinae* in which the gills are much specialized includes those which have been adjusted to an environment of mud and sand. Nearly all of these nymphs have the number of gills reduced. In *Ephemerella excrucians* there are but five pairs of gills and these cover but two abdominal segments. The attachments are in every case protected by lateral spinous extensions of the abdomen. In *Ephemerella rotunda* and *E. excrucians* a wide hollow shelf is formed from these spines, upon which the gills rest. Each gill consists typically of a thickened lamella, which completely overlies the delicate fimbriate-lamelliform division beneath.

The thickening of the upper lamella is greatest upon the front gills. This thickening and the reduction in number of the gills is most marked in the two mud dwellers, *Caenis* and *Tricorythus*. In these, gills are present upon segments two to six only. In all species of both genera the upper lamella of the first gill is modified into a cover which conceals all of those behind it. They are further protected by a shelf-like extension similar to that just described in *Ephemerella*. In the slight concavity of this shelf lie the delicate gills of segments 4, 5, 6, protected from the harsh gravel through which the nymphs crawl. When breathing actively the stiff covers are raised enough to allow water to circulate upon the gills beneath, which vibrate freely and create a current.

The gill covers of *Tricorythus* are scoop shaped, with the concavity beneath, so that even when the cover is closed down the gills are not under pressure, but are enclosed in a protecting box. The edges of the cover and those of the gills beneath are margined with short hairs. This brush of intermingled hairs makes an effective sieve which strains out particles of mud from the incoming current of water. Entrance of water at the base of the gill is prevented by a small triangular extension of the second abdominal segment which fits closely to the inner side of the elyteroid cover.

#### *Gills of the Ephemerinæ.*

The most homogeneous series of gills is found in the *Ephemerinæ* which in Fall Creek were represented by *Potamanthus*, *Polymitarcys*, *Ephemera* and *Hexagenia*. They are single and rudimentary upon segment one, (Pl. XLIX, Fig. 27) and double upon segments 2-7 (Pl. XLIX, Fig. 26). They are long and generally narrow, but this varies slightly with the genus. The upper and lower lamella are both fringed with filaments into which run branches of the tracheæ. The attachments are not protected and the base of the gills appears to be an unbroken continuation of the body wall, which is very flexible and tough. The gills of *Potamanthus* (Pl. XLIV, Fig. 7) are the most generalized. They are nearly linear, lie limply extended from the sides of the body and except for the scanty fringe of filaments are almost identical with the gills of *Lep-tophlebia*.

In the true burrowers, *Ephemera* (Pl. XLIV, Fig. 8) and *Hexagenia* (Pl. XLIX, Figs. 26, 27) both lamellae are broader and the number of the marginal filaments is more than doubled. Each lamella is stiffened by a mid-rib of chitin which overlies the main trachea. By the aid of this rib the gills can be held up over the back where they are not exposed to the constant friction as they would be when trailing from the sides.

*Gills of the Heptageninae.*

The gills of the Heptageninae (Pl. XLV, Figs. 10, 11, Pl. XLVI, Fig. 12) show a series of slightly less homogeneous adjustments. They are fitted for breathing in different degrees of rapid water, and at their maximum specialization, they are important aids to the nymph in clinging to surfaces. The gills are double except the last one which in *Heptagenia* is rudimentary. (Pl. XLV, Fig. 10). The upper division is plate-like and shows greater modification and the lower part is fimbriate-lamelliform or fimbriate, and varies slightly in size and position among different genera. The gills of the *Heptagenia* and *Epeorus* have the characteristic abundant tracheation of swift water inhabitants. In *Epeorus* the lamellae are large, richly tracheated and lie obliquely recumbent along the sides of the body, (Pl. XLII, Fig. 4), so that the tips and outer edges touch the surface upon which the nymphs rests. Along this edge is a chitinized band thickly beset with spines. When clinging to stones in the rapid current this edge is pressed tightly down to the surface. The bases of the gills are protected by sharp extensions of each tergite, which project backward over them. On the inner margin of each lamella near the base is a shallow notch. When the lamellae are held close to the body the fimbriate gill projects through this notch and receives the full wash of the water. The first pair of lamellae are scoop-shaped and curve inward back of the hind legs so that little water flows beneath the body.

In *Iron fragilis* there is a similar, but more perfect adhesive apparatus. The outer margins of the lamellae are likewise banded and their position is identical with that just described. The first pair of lamellae are much larger. (Pl. XLVI, Fig. 12), and their tips are held almost in contact. The last pair are folded and slightly curved so that the tips of these also nearly touch. When the margins of these lamellae are closely pressed

against the surface a sucking disk is formed. In the lamellae and in the fimbriate gill above, the tracheae absorb oxygen from the water constantly flowing over them. An adhesive apparatus is thus coupled with an efficient respiratory organ.

*The Food of the May-fly Nymphs.*

May-flies are almost entirely herbivorous. Their food consists chiefly of fragments of higher plant tissue, algæ and diatoms. The following table contains the record of an examination of the stomach content of several nymphs. With the exception of Siphurus and Chironetes the examinations were made upon fresh material:

STOMACH CONTENTS OF NYMPHS EXAMINED THROUGH APRIL AND MAY. CROSSES (X) REPRESENT SUBSTANCES FOUND IN MORE THAN TEN SPECIMENS OF A GENUS.

	Siphurus	Heptagenia	Blasturus	Hexagenia	Callibaetis	Chironetes
1. Fragments of Plant Tissue.						
Stems, decayed leaves.....	X	X				
Epidermis.....	X	X				
Epidermis, moss.....	X					
Epidermis, roots.....						X
2. Filamentous algæ.						
Vaucheria.....	X					
Spirogyra.....	X				X	
Mougeotia.....	X					
Ulothrix.....	X					
Zygnema.....	X				X	X
3. Diatoms.						
Navicula.....	X	X		X		
Fragellaria.....	X	X	X			
Tabellaria.....	X	X				
Cocconeia.....		X	X	X		
Meridion.....			X			
Gonphonema.....			X	X		X
Synedra.....						
4. Animal.						
Mayflies.....	X					X
Other insects.....						X

The kinds of algæ and diatoms found in the stomach varied a good deal with the locality and date of collection. In certain parts of Cold Brook during March, 1911, every available object was brown with Meridion and the stomachs

of nymphs collected there contained little else. Nymphs taken in the same place a month later contained no fragment of *Meridion*. May-fly food is most abundant in April and May, especially for the running water forms. Later the thick mats of *Meridion*, *Cladophora* and *Spirogyra* begin to decay, there is a diminished supply of water and consequently greater competition for food.

In the summer of 1911, a few experiments in feeding were made upon *Callibaetis fluctuans*, one of the most abundant local May-flies in pools and open waters. Six pails about one foot deep and seven inches in diameter were made from strong muslin. A ring of wire was placed at top and bottom to extend them. A string was tied into the upper one for a bale and the pails were fastened to a frame and suspended in a pool where the water was kept constantly fresh. They were numbered 1, 2, 3, 4, 5, 6, and a different food placed in each respective pail.

On June 28, twelve nymphs of equal size were measured and freed in pail. On July 1, nymphs were taken from each pail and the stomach contents examined. For ten days more the same food was given at intervals of two days. Occasionally the pails were rinsed free of stale food. This was especially necessary for the corn meal which soured quickly.

June 28 12 Nymphs in each Pail	July 1 Alive	July 1 Stomach Content	July 10 Alive
1. Fruiting chara.....	All	Not much food, fragments chara.....	All
2. Corn meal.....	All	Half full of meal.....	6
3. Alfalfa (ground).....	All	Not much food, fragments alfalfa.....	9
4. Spatter-dock (ground).....	None	Full of spatter-dock tissue.....	7
5. Green grass (ground).....	7	Half full, green grass.....	All
6. Fruiting chara (control)...	All	Full of chara.....	

### *The mouth-parts of May-fly Nymphs.*

#### *Bætinae*

The most generalized mouth-parts occur among the *Bætinae* in the species which bite or tear fragments from roots and stems. They consist of labrum, labium, mandibles, maxillæ, hypopharynx, and the epipharynx which is borne upon the labrum. Those of *Callibaetis fluctuans* (Pl. XLVII, Fig. 14),

are typical of this generalized condition. On the concave inner surface of the labrum are two patches of incurving hairs, and these are supplemented by a set of long marginal hairs. When gathering food the edge of the labrum is pressed against a stem or leaf and moved rapidly back and forth. After a few movements its tip is pulled close to the mouth and brushed by the maxillary palpi. The labium sweeps food in from behind as the labrum does from the front. On the maxillæ which lie in front of the labium the lacinia and galea are fused. The lacinia is represented by two teeth on the tip; the galea by the lobe like part behind them. The teeth of mandibles are separated into two distinct groups, the canines (c) and the molars (m). In many cases both of these are very asymmetrical. Both maxillæ and mandibles may be freely extended side wise, but the latter is used less often for biting than for grinding. The epipharynx (cf. Pl. XLVII, Fig. 14b) is an inconspicuous elevation which is borne on the inner surface of the labrum. It is densely covered by short incurved hairs probably sensory. It often extends on to the clypeus and in all the nymphs examined lies a little to the right of the center. Mouth-parts of the type described above are found in nymphs of *Siphylurus*, *Blasturus*, *Baetis* and *Leptophlebia*. The food getting habits of any of these can be easily observed. They pull off fragments from the stems and leaves by sticking the lacinia or less often the canines into the tissue, then bracing with the front feet and pulling backward. Upon flat surfaces, they keep the labrum and labium moving rapidly and thus sweep the food into the mouth.

In nymphs of *Ameletus ludens* a broad plankton rake upon the maxillæ formed by a series of arched, regularly graduated, and pectinated hooks borne upon the distal end of the galea and lacinia. When eating, the nymph extends these rakes forward and backward, exactly as one would use a hand rake and by the help of the labium and hypopharynx the food is pulled into the mouth for grinding.

Nymphs of *Chironetes* gather their food upon ledges washed by dashing water. The outer surfaces of the mouth parts are armed with very long bristles. The distal segment of the labial and maxillary palpi are flattened out into broad blades. These blades are used as scrapers upon the algæ covered stones. In the swift current this nymph must of necessity

cling to the rocks with its head upstream. In doing this it uses its fore legs little, but they are held up and straight forward close beneath the labium. Armed with long bristles as they are, they help to form an efficient plankton basket which catches the food carried along in the water.

In *Caenis*, *Tricorythus* and *Ephemerella* the mouth-parts are often reduced. In all these the mandibles are stout with very strong canines (Pl. XLVII, Figs. 16, 19, and Pl. XLVII, Figs. 20, 21). Structures like the palpi which extend out from the mouth are much shorter. In *Tricorythus* (Fig. 22), the body of the labrum is strong, but the palpi are weak and stubby. This reduction is carried to the limit in the maxilla of *Ephemerella deficiens* in which the palpi have disappeared, leaving only a little peak of chitin at their attachment place (Fig. 18). If one observes nymphs of *Tricorythus* or *Ephemerella* foraging, they will see them continually thrusting their heads through harsh gravel where such appendages would be in the way.

The *Bætinæ* have the most generalized mouth-parts examined. This group includes species in which there have been modifications of the mouth-parts for rakers and plankton baskets, and great reduction of palpi.

#### *Ephemerina*

Nymphs of *Potamanthus*, *Polymita* and *Hexagenia* all gather their food in the same places and by the same means. Their relative specialization has been closely correlated with the extent to which they have been modified for burrowing. The mandibles of *Potamanthus* (Pl. XLVIII, Figs. 23 and 24) show the beginning of this modification. The canines are here in their usual position at the tip of the mandible (c), but upon the outer side of each is a stout pointed process. These processes are not long, and when the mandibles are in natural position only their tips show beyond the labrum. These processes are similar in shape and identical in position with the tusks of the true burrowers, *Ephemera* and *Hexagenia* (Pl. XLIX, Figs. 31, 36). In these the processes are long, slightly incurving tusks which are the most conspicuous features of the head. The canines are on the median side of these near the base, and when the mandibles are in natural position, they extend downward and can thus most efficiently grasp



food. From them the food is passed inward to the grinding surface of the molars. Upon the left molar (Pl. XLIX, Fig. 34) are eight deep transverse gutters. The upper ends of these are enclosed by irregular teeth and the floors are marked by transverse striations. The right molar (Fig. 35) surface bears seven overlapping ridges, all but one of which is bluntly toothed and enclosed at one end by a prominent jagged process. When in position the ridges of the right molar fit down into the gutters of the left and the terminal teeth fit into the free ends of the gutters. The food brushed into the mouth by the labium and maxillæ is ground in this mill.

In the Ephemerinæ the greatest modification has occurred in the mandibles which have become the strongest structures of the head, important alike to feeding and burrowing.

#### *Heptageninæ.*

In the Heptageninæ which have scraping mouth-parts, the labrum is entirely hidden from above. It is freely movable upon the clypeus and has a row of very dense, slightly incurved hairs extending along its margin. The inner surface of the labrum is slightly concave, and bears the epipharynx. When the labrum is extended forward the short hairs upon the inner surface rake in the food and are closely followed by the thick brush upon the margin. Food thus gathered in the concavity of the labrum falls directly between the maxillæ and mandibles.

#### *Legs of Nymphs.*

The legs of May-fly nymphs consist of a coxa, trochanter, tibia, tarsus and a tarsal claw. These parts vary in relative size and structure according to the habit of the nymph. The surfaces may be bare, scaly, spinose or hairy. In all of the legs which have been examined there is a small but distinct plate on the inner side at the distal end of each tibia.

#### *Bætinæ.*

The Bætinæ includes nymphs which have the most generalized legs, such as those of Siphilurus, Callibætis, Ameletus and Chironetes. All of these nymphs can move about upon a heterogeneous footing (Figs. 3 and 5). The legs of Siphilurus are of the most generalized type. They are long and slender and the three pairs are of equal length. The surfaces are sparsely covered with inconspicuous hairs. The tarsal claw

is long, slender and without teeth. The tibial plate is well developed, consisting of a thick, flattened projection of the tibia, which bears transverse ridges. The attachment of the legs allows free movement and the nymphs are capable of running very swiftly. The middle and hind legs of *Chironomites* are similar to those which have been described, but the first pair has been modified for food gathering and respiration. At the base of the coxa, there is a large tuft of forked gill filaments. From the tibia an elongate flattened spur extends for more than half the length of the tarsus, and along the inner margin of femur, tibia, and tarsus is a regularly arranged row of very long, stiff hairs. When the legs are sharply bent, these hairs, together with the tibial spur form the bottom of the plankton basket already referred to.

In *Cænis*, *Tricorythus* and *Ephemerella* the legs do not lift the bodies at all. Nymphs of *Cænis* and *Tricorythus* clamber upon very uneven surfaces so that the legs do not extend straight out from the body as they do in some of the *Ephemerellas* later noted. The strain of pulling and climbing comes evenly upon every segment of the leg and there is little difference in their size. In both of these genera the tarsal claws are in constant use and are correspondingly well developed. The same evenly distributed development may be seen in the legs of certain *Ephemerellas*, which constantly crawl over mud, dead leaves, and small debris. In others in which there are well established clinging habits (Pl. L, Figs. 39, 43), the fore femora are enormously developed by the constant pulling incident to their position. In these legs the hinder part of the femora is greatly thickened by the muscular development, but the front edge is thin and blade-like and often jaggedly toothed or serrate.

#### *Ephemerinæ.*

Two stages of modification are shown in the legs of *Potamanthus* and *Ephemera*. In *Potamanthus*, which crawls upon the bottom in a manner similar to the *Heptageninæ*, the legs sprawl out from the body in the same way. The tibia is prolonged into a flat spine which overlaps the first third of the tarsus. The structure of this fore leg appears to be the fore-runner of the greater modification shown in the fore legs of *Ephemera*, (Pl. XLIV, Fig. 8), which are perfect digging tools.

## V. MODIFICATIONS OF ADULT STRUCTURES.

Reproduction is the sole end of the imago life. Parts of the body which have no function connected with it are reduced or atrophied.

It is probable that, with but few exceptions, May-flies engage in some kind of mating flight. The character of this flight and the time when it occurs vary. The following records show some of these variations. On June 25th a swarm of three or four hundred individuals of *Choroterpes basalis* were swarming over the water of Fall Creek at about four o'clock on a sunny afternoon. Their average rise must have been thirty feet. From the swarm both males and females were captured, but mating was not observed. On June 29th, at 7:30 in the evening, a female *Ephemera varia* was captured from a swarm which was rising and falling in flights of thirty to forty feet. Often they descended to within five feet of the ground. Their dance continued until darkness hid them. Mating flights of *Leptophlebia prapedita* have been seen in the middle of a sunny forenoon, and at two, four and five o'clock of bright afternoons in May and June. None of these rose higher than fifteen feet and two of the swarms did not fly more than six feet above the ground. One entire swarm which was captured contained forty males and one female.

Actual mating has been observed but a few times. The most satisfactory observation was made in May, 1911, upon a swarm of *Bætis*, which were flying near Cascadilla Creek just after a shower. Most of the time they were not flying much above the level of the eye so that they could be clearly seen. Large numbers continually settled on bushes and upon my clothing, and there appeared to be about equal numbers of males and females. Many matings occurred, but in only seven could the positions of the insects be seen at all. The male of one of the couples flew up and attached himself beneath a female, pressed the dorsal side of his head against the ventral side of her thorax and extended his fore-legs upward, in order to clutch her prothorax. The setæ of the female extended straight out posteriorly, but those of the male were pointed forward over his back so that their tips projected between the heads of the two insects. The position of the abdomen could not be clearly seen, but judging from that of the setæ, it

must have been recurved in order to insert the penes inside the egg valve. Copulation did not last more than half a minute. When in copula, each pair was borne diagonally downward to the ground, but always separated immediately upon touching it.

So far as known flight is a necessity for copulation and egg-laying in May-flies. The alimentary canal and the legs play a part in flight which is peculiar to this group. It is a well known fact that adult May-flies take no food and that the alimentary canal is inflated with air or gas. Sometime before emergence the nymphs cease to eat and just before it, they push their heads above the surface and appear to be rapidly gulping in air. If dissected at this stage the alimentary canal is found much inflated. It remains thus inflated throughout life. The structure of the alimentary canal of adults was studied by Fritze, '06 and by Sternfeld, '07. Sternfeld found a complicated muscular dilator apparatus in the esophagus. This he concluded to be a pump by which the mid-gut was filled with air and by which its supply could be voluntarily controlled. He did not discover whether any change occurred in the air taken in. No suggestion was made as to when this pump was used, but it is probable that it functions when the canal is first inflated by the nymph and afterward in controlling the specific gravity during flight. This change of the alimentary canal from its normal function to that of a balloon is very important to flight. The lessening of the specific gravity made possible by this modification makes the work of the wings much easier. Since it is more important that adults mate, than that they live a long time, this function of the alimentary canal exceeds the former one in value.

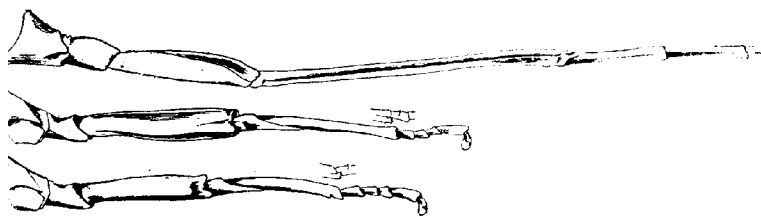


Fig. 1. Legs of male imago of *Hexagenia bilineata*. A, first leg; B, second leg; C, third leg; 1, opposite side of legs showing tibial spur.

It has already been noted that adult May-flies use their legs little or none in walking and in many instances the fore legs are not even used for support. In most males the fore legs are enormously lengthened and when the insects are at rest, they are often extended out from the head (Pl. XLIV, Fig. 9). The middle and hind legs brace the body, but they usually lift only the front part, while the abdomen rests upon the supporting surface (Pl. XLIII, Fig. 6). The fore legs are necessary structures in copulation and males of *Palingenia* which have very short legs mate not in mid-air, but close to the surface of streams. (Eaton). The legs of some May-flies have been enormously specialized. The fore-legs of a South American *Campsurus* are very long, (see Fig. 3), while the middle and hind ones are but short stubs. In the fore legs there is a twist in

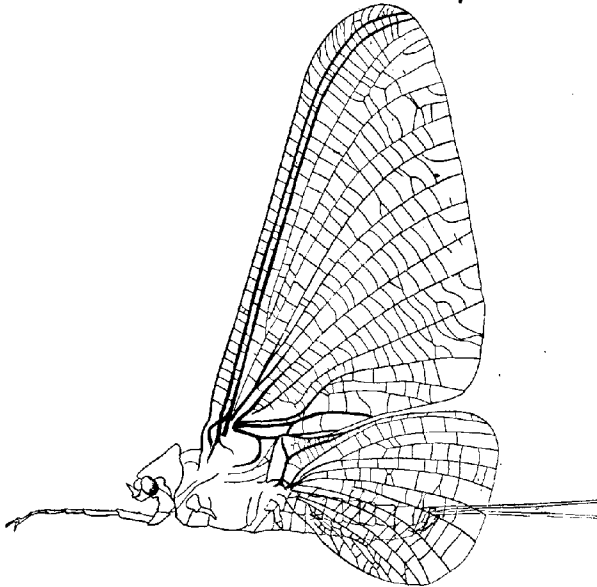


Fig. 2. Male imago, *Campsurus* (South America) showing rudimentary middle and hind legs. The setæ not represented at full length here, are about three times the length of the body.

the joint which articulates the tarsus with the tibia. This admits the supination of the tarsus and is evidently a modification for clutching the female.

*External Genitalia of the Male.*

The external genitalia of the male consists of a pair of forceps, jointed except in *Cænis* and *Campsurus*, and two penes, each with a distinct opening. The forceps are incurved appendages of the tenth segment, by which the male grasps the abdomen of the female. The genitalia of *Hexagenia*

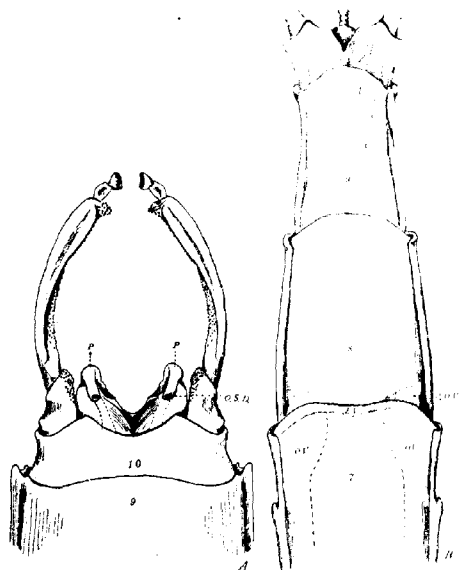


Fig. 3. A, external genitalia of *Hexagenia* sp.? ♂; p, penis; o, o. d., opening of seminal duct; f, forceps. B, ventral view of rear abdomen of *Hexagenia* sp.? ♀, showing ov., outline of oviduct seen through body-wall; o, ov., opening of oviduct; e. v., egg-valve; 7, 8, 9, 7th and 8th sternites.

sp.?\* are of the simple type. The forceps are three jointed, with a stout basal piece. The two distal segments are concave on the inner surface and tip. These concavities, the flap like extension upon the main segment and the inner surface of the basal piece are thickly covered with small papillæ, which are characteristic of nearly all forceps examined. The roughened surface produced by them probably

\*This is a species *Hexagenia recurrata* in manuscript which I have to be published.

helps to hold the female. The penes are the intromittent organs. In *Hexagenia* they consist of two chitinous funnels whose larger ends open inside the body, and whose smaller ends are slender tubes bent down ventrally. Between the penes is a thin chitinous plate, and beneath they are supported by the tenth sternite. In each penis the seminal duct can be clearly traced to its termination at the end of the bent tube.

Of the more complicated condition which exists in most May-flies, the genitalia of *Siphilurus alternatus* is fairly typical (Pl. LI). The forceps are similar to those of *Hexagenia*. Their origin from the ninth sternite is shown in Figures 48 and 49. The penes (P) are wholly hidden from beneath by the tenth sternite, but they are attached only at their bases, and in copulation may be freely projected within the (Fig. 50, EV) egg valve, while the tenth sternite remains outside it. Essentially they consist of the funnels just described in *Hexagenia* with secondary structures added. The larger ends of the funnels open into the body (Fig. 49, A). In Figure 49 the penes are shown in dorsal view, separated off from the dorsal part of the abdomen with the large ends of the funnels exposed (A). The small end of the funnel (B) extends outside the body and turns downward as in *Hexagenia*, but the opening of the seminal duct is enlarged and trumpet-shaped. From the dorsal side only the backs of these trumpets can be seen, but when the penes are completely removed from the ninth sternite and turned with their ventral sides up, one can look directly down into their openings, (Fig. 52, O. S. D.) and the seminal ducts can be traced from the testes directly to them. Lying dorsal and lateral to each seminal tube are two prominent, heavy chitinized processes (Fig. 49). The raised apex of the upper process (C) is pointed toward the middle, that of the lower (D) is pointed outward toward the side and the prominent spines upon each are directed in different directions. If the supposed position of the penes in copulation, be correct, the dorsal or spinose surface of these processes must be in contact with the inner surface of the egg valve (E. V. Fig. 50). When inserted they would thus hook over its soft lip and pull it down, allowing the seminal tubes to discharge their contents at the mouth of the oviducts.

*Genitalia of the Female.*

In the simple condition each oviduct lies well to the side of the abdomen and opens between the seventh and eighth sternites (Hexagenia). Each opening is perfectly distinct (see dotted line Fig. 3, B) and there is no sign of an open passage or vestibule between the two.

In *Siphylurus alternatus* (Pl. LI, Figs. 53, 55) the lower ends of the oviducts approach each other and open into a common vestibule (C. V.) just inside the egg valve. Opening into this vestibule is a soft membranous sac (S. R.). In fresh specimens this sac shows prominently between the bases of the oviducts (Figs. 53, 55). In figure 55 the sac and oviducts are shown viewed from the inside; the nerve chain has been severed so as to fully expose the sac. In the specimens thus far examined, no spermatozoa have been found within this sac. It is extremely probable, however, that this is a true seminal receptacle, and that this is a specialization which nearly approaches the unpaired opening found in other insects.

## VI. THE EGGS.

Under the ordinary conditions of their life a large proportion of May-fly nymphs regularly perish before reaching maturity. A great excess of young must be produced in order to meet this loss and the success of different groups in maintaining their existence becomes more than usually dependent upon the number of eggs produced and the structures which aid in their dispersal and safety during incubation.

In insects whose lives are so brief as these, the eggs are well developed even at emergence, and may then be readily counted, the difference in size between the developed eggs and the egg rudiments being very marked. It is easy, therefore, in mature nymphs, sub-imagos or imagos to determine the actual fecundity.

The first count of May-fly eggs was made by Reaumur\* to determine the fecundity of some specimens which he captured in his garden. He found egg masses protruding from the abdominal openings, counted the eggs and found about 400 in each mass. His results have been several times quoted by later workers, but no references has been found to any

\*Reaumur 1742. T. VI, Mem. XII, p. 495.



other actual determination of the fecundity of May-flies since that time.

In this study the eggs of seventeen May-flies have been counted and examined. They were taken from imagoes which had been kept in cages until they showed signs of old age. Usually a count was made of the eggs in several individuals and an average taken. They were examined and counted upon a glass slide in a mixture of water and glycerine which formed a convenient medium in which to manipulate them. The results of the counting are given in a table which follows.

All of the eggs are viscid. When laid in dishes they adhere to the bottom, as do those of *Bætis* to stones. When twigs or algae are introduced, they become attached to them. There are two kinds of structures found upon them; micropylar structures and knob or thread-like extensions of the chorion, both of which are important to the egg; and there is also a variety of chorionic sculpturings which have no apparent significance.

Examples of the more important structures were long ago pointed out. Polar knobs (micropylar structures) were figured by Burmeister '48, and described by Leuckart '55. The latter believed that the knobs were composed of masses of spermatozoa and it remained for Grenacher, '68, to find many stages of them upon developing eggs in the egg-tubes and to point out their true nature. Micropylar structures were also shown in *Palingenia virgo* by Joly, '71 and '76, and in *Bætis sulphurea* by Joly, '76. Grenacher, '68, also pointed out (upon an unnamed May-fly egg) some little threads which were continuous with the chorion and which bore tiny spheres upon the ends. He figured these with remarkable accuracy. Of the eggs here figured, three bear a micropylar apparatus, five have thread-like extensions of the chorion and nearly all are more or less elaborately sculptured.

The eggs of closely related forms may be very different. This is well shown by a comparison of those of *Ephemerella excrucians* and *E. rotunda* (Pl. LIV, Figs, 66, 67). The eggs of *Ephemerella excrucians* are pure white, and slightly dumb-bell shaped, with a distinctly sculptured chorion, but with no micropylar apparatus. Those of *Ephemerella rotunda* are yellowish and oval with a prominent mushroom shaped cap about the micropyle. If examined in the body or when first extruded, two small knobs may be seen upon either side of the egg, near its lower pole. Each knob is attached to the

distal end of a thread-like extension of the chorion, which lies beneath it, tightly coiled like a watch spring. Upon coming in contact with the water these threads spring out like elaters. The little knobs thus extended probably act as floats or anchors for the egg. An even greater difference between the eggs of closely related forms may be seen in the eggs of *Heptagenia interpunctata* (Pl. LIII, Fig. 65) and *Heptagenia pulchella* (Fig. 64). The former has a pure white oval egg without sculpturings or extensions of any kind. The latter is white and slightly rounder with small regularly arranged bosses upon the chorion. At each pole there is a skein of fine bright yellow thread. These skeins are also prominent upon the poles of developing eggs, even in the tips of the egg-tubes. Upon a glass slide they are easily seen with the naked eye and the threads may be pulled out with needles to a length of two or three inches. As soon as the eggs float free in water the skeins begin to unroll and if shaken a little they quickly uncoil altogether and become entangled with any object near them. In nature the eggs are deposited upon the surface of moving water. The threads just described probably wind about sticks or plants and thus anchor the eggs and keep them from being buried with silt during incubation.

Similar extensions of the chorion are found upon the eggs of *Tricorythus allectus* and *Ecdyurus maculipennis*. The eggs of *Tricorythus* (Pl. LII, Fig. 60) are bright green and oval with a prominent shingle-like surface. Upon each side of the egg toward the lower pole are two threads very similar to those of *Ephemerella rotunda*, but without any knobs upon the ends. At the other pole is a prominent smooth yellowish micropylar apparatus. The eggs of *Ecdyurus* (Pl. LIII, Fig. 62) are roundly ovate and pure white. Their entire surface is covered with minute pits and scattered between these are numerous short blunt projections. When the egg is first removed from the body, a small coil of thread may be seen in the depression on the top of each projection. As soon as the egg has been in the water a little while, each coil unwinds with a sudden spring. At the end of each thread is a tiny viscid button.

The eggs of *Leptophlebia* sp.? (Pl. LII, Fig. 58) are elongate ovoid, distinctly brownish and thickly covered with short hairs, so that they look like ciliated protozoans. Those of *Choroterpes basalis* (Pl. LIII, Fig. 63) which are laid in the same

or similar situations have no extensions of the chorion. They are pure white, elongate, with an elaborate design in the sculpturing. The eggs of *Blasturus cupidus* (Pl. LIV, Fig. 68) are slightly flattened and tablet-like. Upon these flattened areas are irregularly scattered pits and bosses which appear shining white in the glycerine and about the longitudinal circumference is a shelf-like extension which bears a large number of strap-shaped pegs. The eggs of *Polymitarcys albus* (Pl. LIV, Fig. 69) are roundly ovate and white. The body of the egg is nearly smooth, but the prominent yellow micropylar apparatus has a distinctly shingle-like surface. The eggs of *Callibaetis fluctuans* and *Chironetes albomanicatus* were perfectly smooth and pure white.

Nymphs of *Hexagenia variabilis* and *Polymitarcys albus* live in the same situations but the eggs of the former are only a little roughened, while *Polymitarcys* has the prominent micropylar apparatus just described. The roughness due to chorionic sculptures may be of some slight service in helping to lodge the eggs, but its significance is probably slight. The extensions of the chorion, on the other hand, are no doubt of much importance in the dispersal and safety of the eggs. The anchors upon *Ephemerella rotunda* and *Tricorythus allectus* hang the eggs upon sticks and stems and prevent them from being buried in the mud; the many viscid threads upon those of *Leptophlebia* and *Ecdyurus maculipennis* accomplish the same result in a different fashion. Those which probably have the most important function are the long threads upon the eggs of *Heptagenia interpunctata*. A number of these were shaken about in water strewn with chara and the threads immediately became closely entangled upon its stems. Eggs thus hung upon stems in natural conditions would be safeguarded and prevented from being buried in the mud.

	Number of egg in both ovaries	Color of egg	Length (Fresh eggs measured in glycerine)	Width
<i>Ameletus ludens</i> .....	670	Light brown	.276 mm.	.153 mm.
<i>Blasturus cupidus</i> .....	3700	White	.177 mm.	.093 mm.
<i>Callibaetis fluctuans</i> .....	500	White		
<i>Chironetes albomanicatus</i> .....	2500	Pale green	.200 mm.	.138 mm.
<i>Choroterpes basalis</i> .....		White	.174 mm.	.085 mm.
<i>Ecdyurus maculipennis</i> .....	1000	White	.170 mm.	.133 mm.
<i>Ephemerella excrucians</i> .....	1950	White	.200 mm.	.125 mm.
<i>Tricorythus allectus</i> .....	750	Green	.189 mm.	.122 mm.

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## EXPLANATION OF PLATES.

## PLATE LXII.

- Fig. 1. Mature nymph of *Blasturus cupidus*.  
 Fig. 2. Male imago of *Blasturus cupidus* just after transforming. The cast sub-imago skin shows the dark wing-pads.  
 Fig. 3. *Ameletus ludens*.  
 Fig. 4. Nymph of *Epeorus humeralis*. The hind wing-pads may be seen through the transparent front ones.

## PLATE XLIII.

- Fig. 5. Nymphs of *Callibaetis fluctuans*, climbing about in their natural habitat.  
 Fig. 6. Male sub-imago of *Callibaetis fluctuans* just emerged.

## PLATE XLIV.

- Fig. 7. Half grown nymph of *Potamanthus bettini*.  
 Fig. 8. Mature nymph of *Ephemera*.  
 Fig. 9. Male imago of *Hexagenia bilineata* showing a posture of the fore legs characteristic of the males of many May-flies.

## PLATE XLV.

- Fig. 10. Right gills of *Heptagenia interpunctata*. The first gill is turned with the lower side up and the fimbriate division is fully exposed; in the others it is indicated through the transparent lamella.  
 Fig. 11. Right gills of *Epeorus humeralis*, upper surfaces. When in the natural position the spinose border is in contact with the surface upon which the nymph rests.

## PLATE XLVI.

- Fig. 12. Right gills of *Iron fragilis*, upper surface, gills turned backward in natural position.  
 Fig. 13. Right gills of *Chironetes albomaneatus*, under surface, gills turned forward.

## PLATE XLVII.

- Fig. 14. Mouth-parts of *Callibaetis fluctuans*. a, right, and d, left mandible; b, labrum, c, hypopharynx; e, right maxilla; f, labium.  
 Fig. 15. Maxilla of *Tricorythus allectus*.  
 Figs. 16 and 19. Right and left mandibles of *Ephemerella lata*.  
 Fig. 17. Left maxilla of *Ephemerella serrata*.  
 Fig. 18. Left maxilla of *Ephemerella deficiens*.

## PLATE XLVIII.

- Figs. 20 and 21. Right and left mandibles of *Tricorythus allectus*.  
 Fig. 22. Labium.  
 Figs. 23 and 24. Right and left mandibles of *Potamanthus bettini*.

## PLATE XLIX.

(Structures of nymph of *Hexagenia*).

- Fig. 25. Maxilla.  
 Fig. 26. Second right gill.  
 Fig. 27. First right gill.  
 Fig. 28. Labrum (La) and Clypeus (Cl), outer aspect.  
 Fig. 29. Labrum (La) and Clypeus (Cl), inner aspect, showing the epipharynx lying partly upon the clypeus and partly upon the labrum.  
 Fig. 30. Antenna.  
 Fig. 31. Right mandible, outer aspect.  
 Fig. 32. Right mandible, inner aspect.  
 Fig. 33. Hypopharynx, under side, showing lingua and superlinguae.  
 Fig. 34. Grinding surface of left molar.  
 Fig. 35. Grinding surface of right molar.  
 Fig. 36. Left mandible, inner aspect.  
 Fig. 37. Left mandible, outer aspect.  
 Fig. 38. Labium outer aspect.

## PLATE L.

- Fig. 39. Right legs of *Ephemerella lata*.  
 Fig. 40. Right fore leg of *Ephemerella serrata*.  
 Fig. 41. Right fore leg of *Ephemerella rotunda*.  
 Fig. 42. Right leg of *Ephemerella deficiens*.  
 Fig. 43. Right fore leg of *Ephemerella tuberculata*.  
 Fig. 44. Right fore leg of *Ephemerella cornuta*.

## PLATE LI.

(Genitalia of imagos of *Siphurus alternatus*.)

- Fig. 45. Rear abdomen of male, F, forceps, ventral view.  
 Fig. 46. Right forceps, showing roughened inner surfaces.  
 Fig. 47. Rear Abdomen, dorsal view, showing c. s., caudal setae; pp, penes and 10s, 10th sternite.  
 Fig. 48. Rear of abdomen, side view.  
 Fig. 49. Dorsal view of penes resting upon the 10th sternite. The white surface, c. e., represents the cut surface of the body wall. The large lobes of the penes, a, lying inside the body have been exposed by cutting away the dorsal part of the abdomen.  
 Fig. 50. Part of the abdomen of the female. c. v., egg-valve, with the opening of the vestibule directly beneath.  
 Fig. 51. Inner view of the 7th and 8th sternites with the oviducts, o. v., and the seminal receptacle turned backward to show the ventral side of the receptacle.  
 Fig. 52. Penes removed from the 10th sternite and viewed from the ventral side. o. s. d., opening of seminal duct.  
 Fig. 53. Egg valve, common vestibule and outline of receptacle and oviducts, from without.  
 Fig. 54. Rear abdomen of female, dorsal view.  
 Fig. 55. Dorsal view of dissection of oviducts and vestibule. The top of the vestibule has been cut away and pulled off with the 7th sternite, so as to expose the inner surface of the common vestibule, c. v., and seminal receptacle, s. r.  
 Fig. 56. Rear abdomen, female, ventral view.  
 Fig. 57. Rear abdomen of female, side view, c. v., egg valve.

## PLATE LII.

- Fig. 58. Egg of *Leptophlebia*.  
 Fig. 59. Egg of *Ameletus ludens*.  
 Fig. 60. Egg of *Tricorythus allectus*.  
 Fig. 61. Egg of *Chironetetes albomaculatus*.

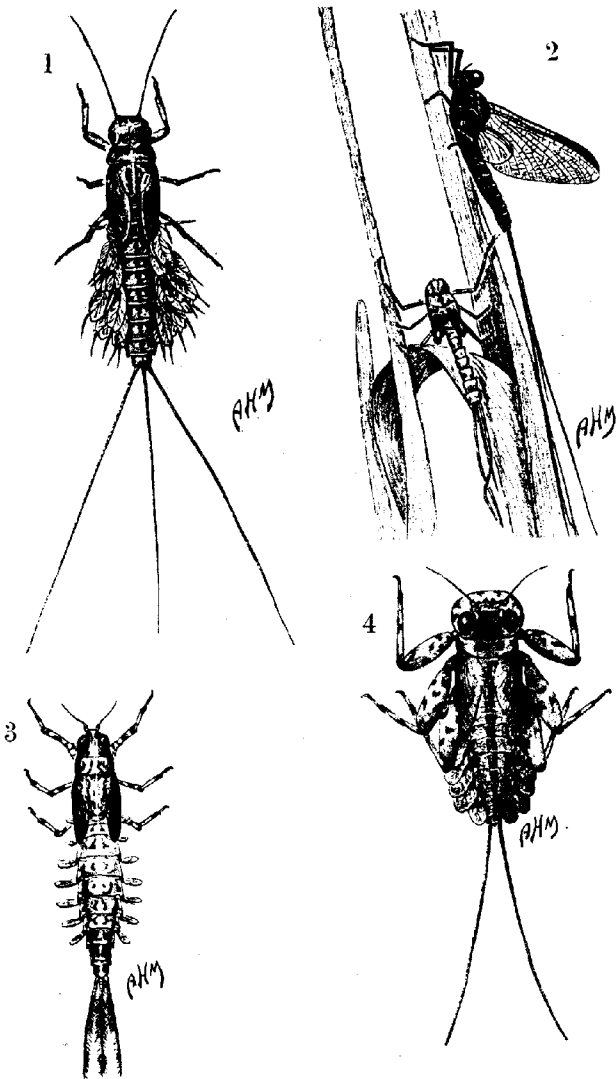
## PLATE LIII.

- Fig. 62. Egg of *Ecdyurus maculipennis*.  
 Fig. 63. Egg of *Choroterpes basalis*.  
 Fig. 64. Egg of *Heptagenia pulchella*.  
 Fig. 65. Egg of *Heptagenia interpunctata*. Needham.

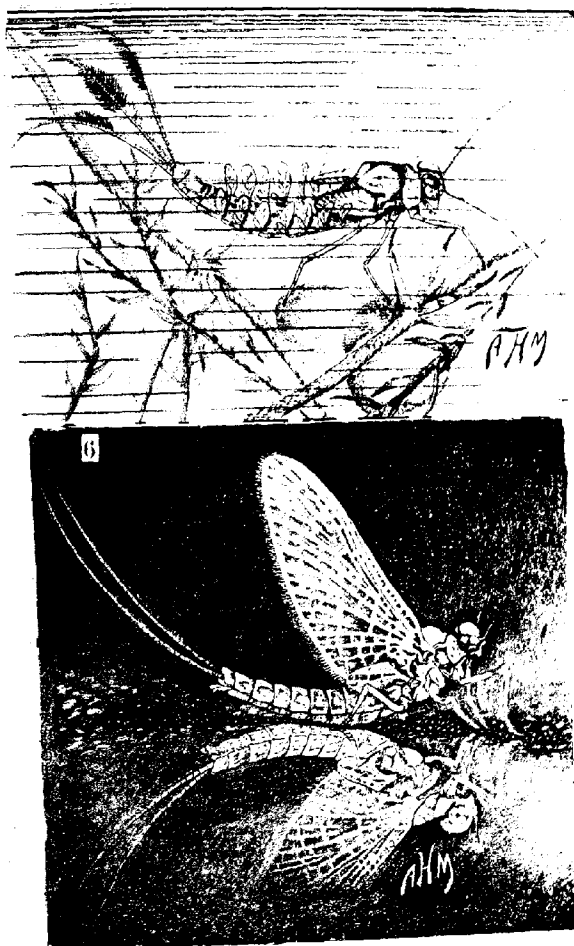
## PLATE LIV.

- Fig. 66. Egg of *Ephemerella rotunda*.  
 Fig. 67. Egg of *Ephemerella excrucians*.  
 Fig. 68. Egg of *Blasturus cupidus*.  
 Fig. 69. Egg of *Polymitaerces albus*.  
 Fig. 70. Egg of *Siphurus alternatus*.

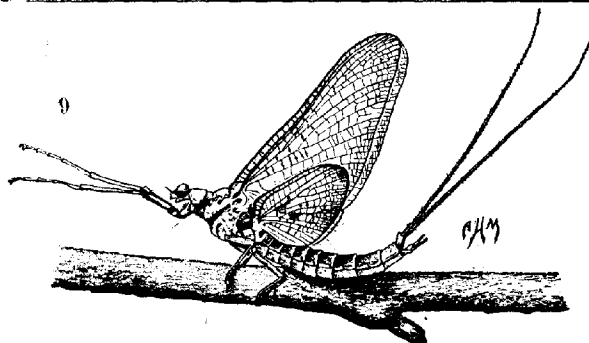


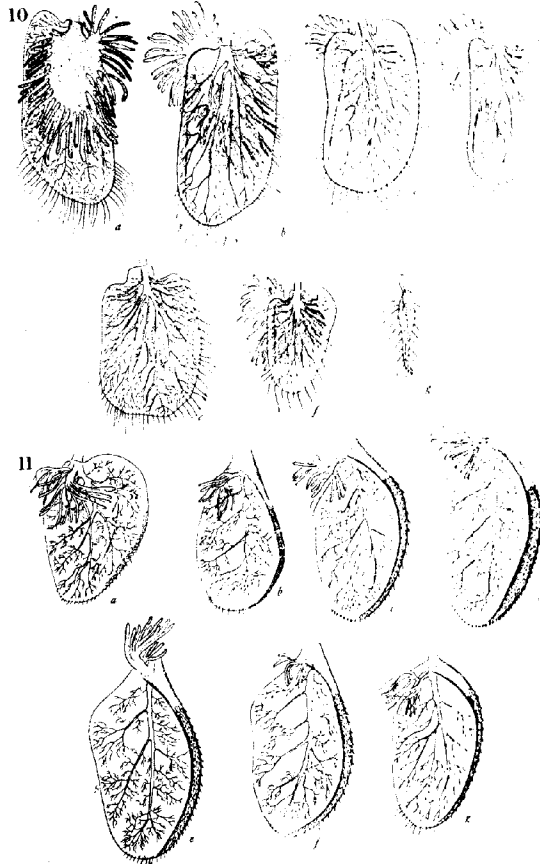


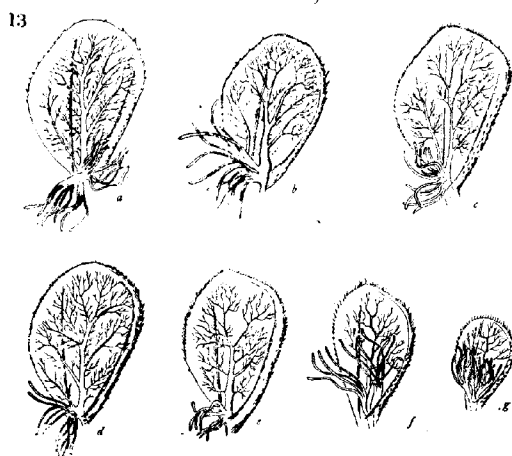
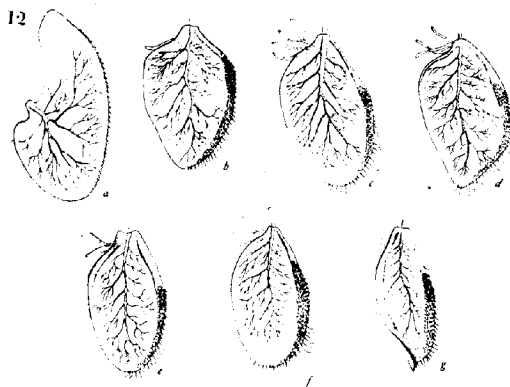
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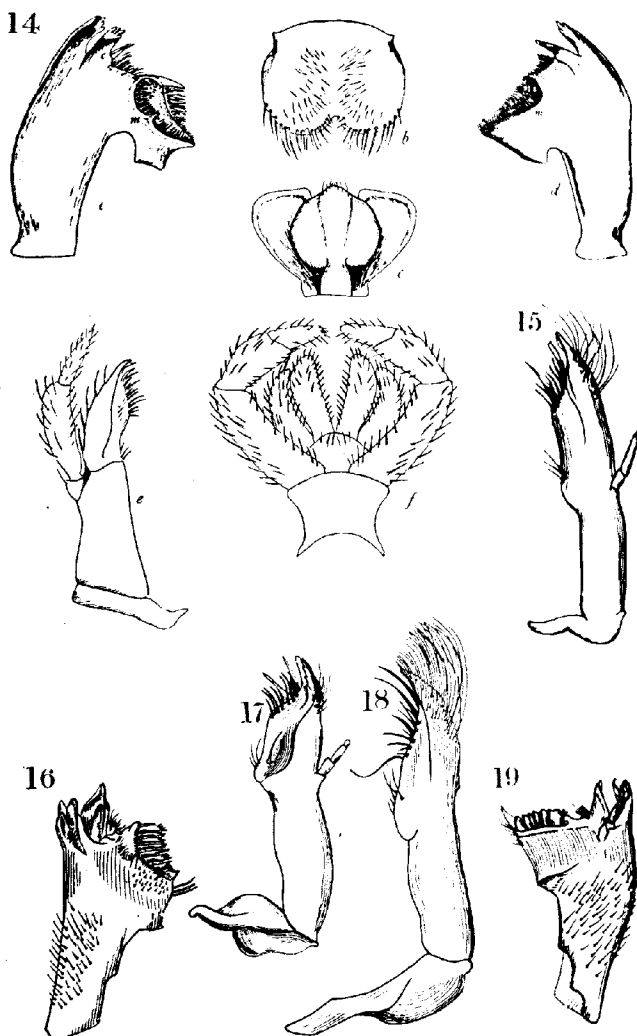


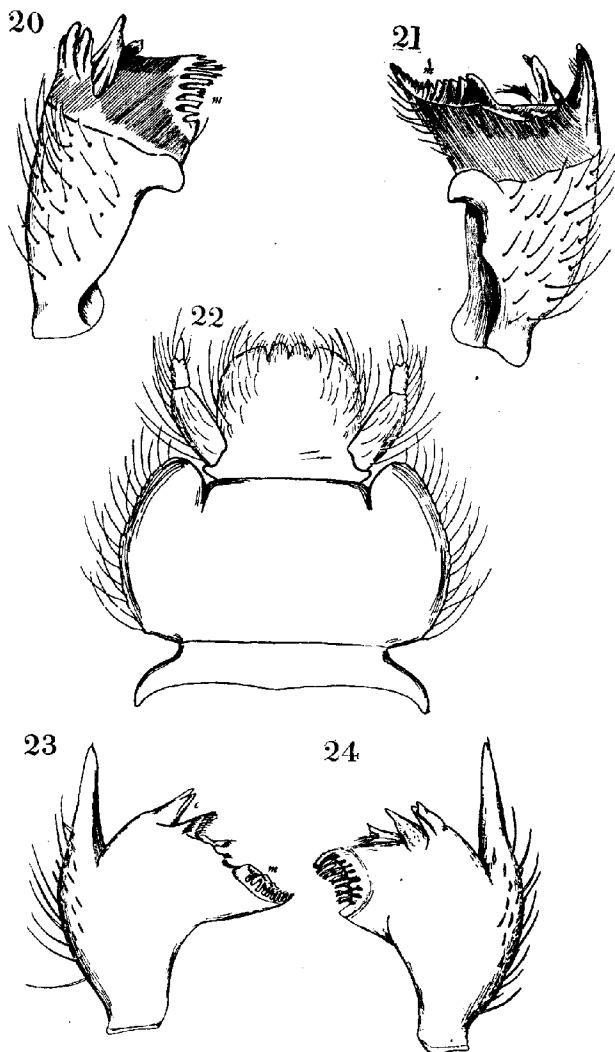
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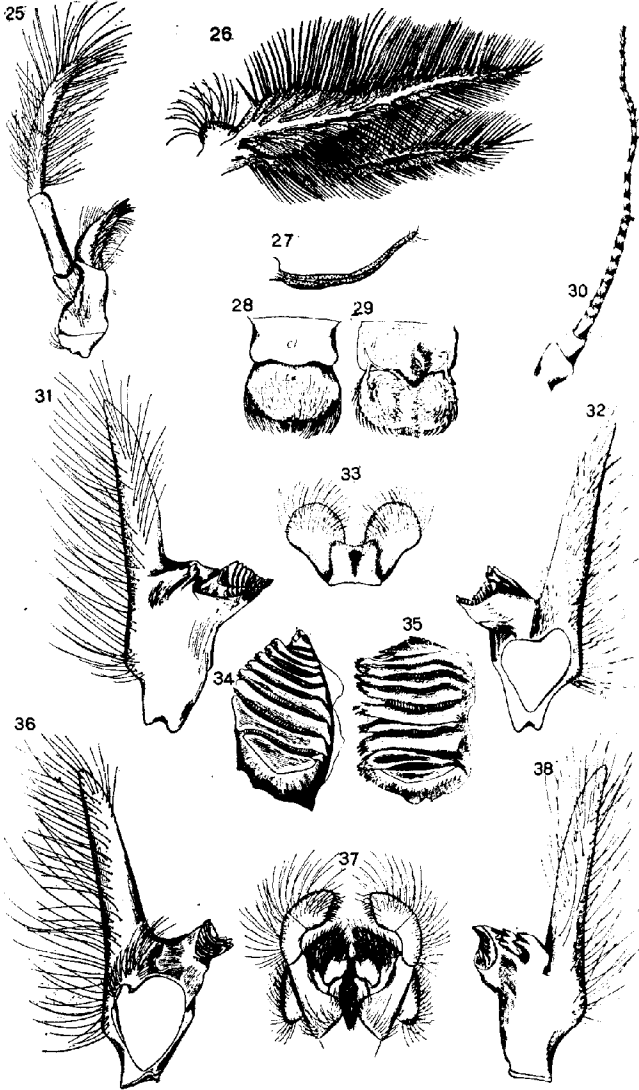






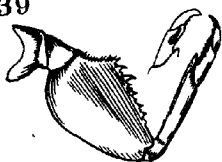




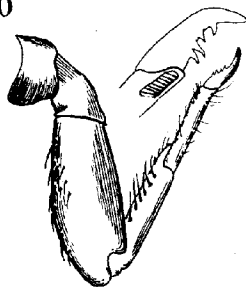




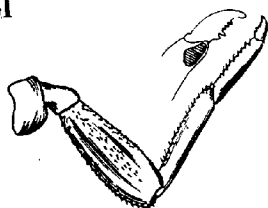
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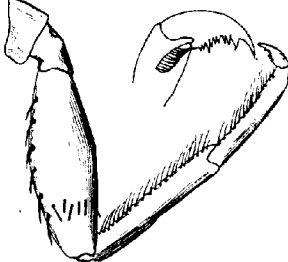
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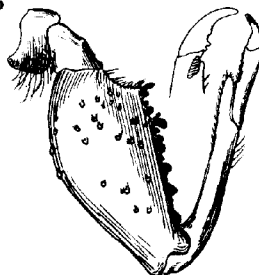
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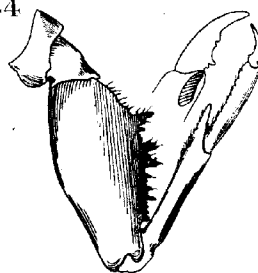
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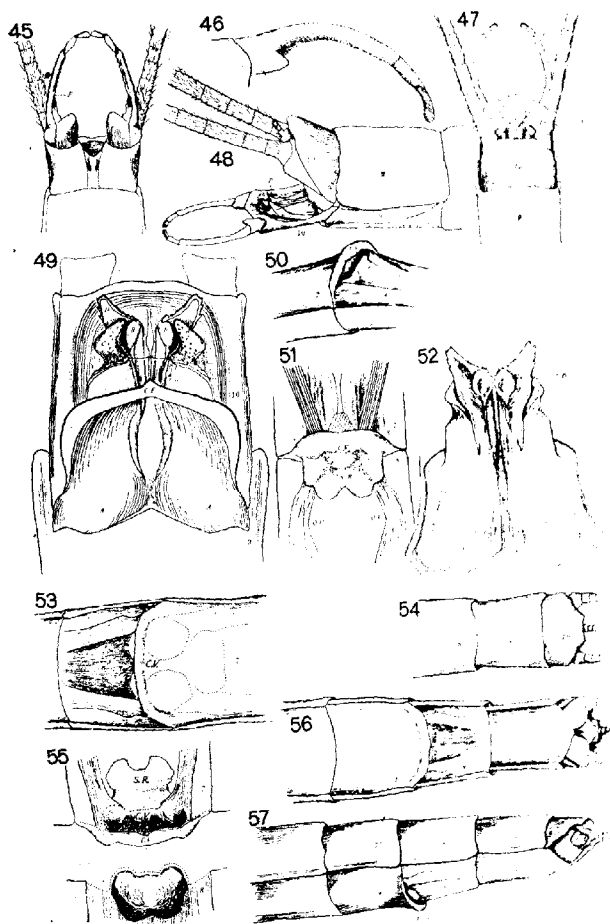


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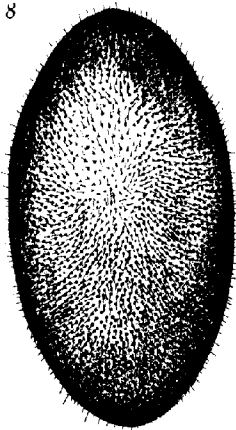


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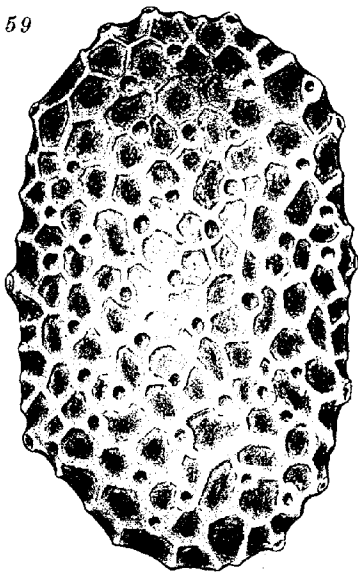




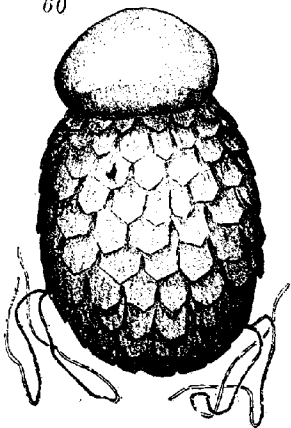
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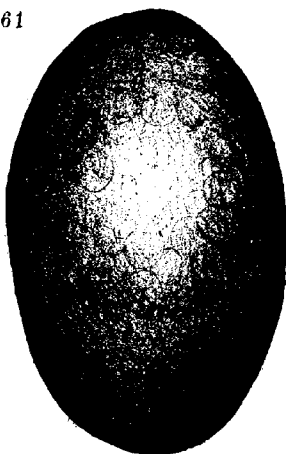
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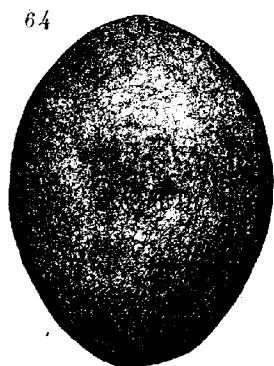
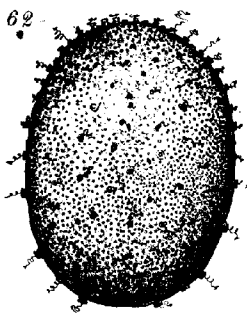


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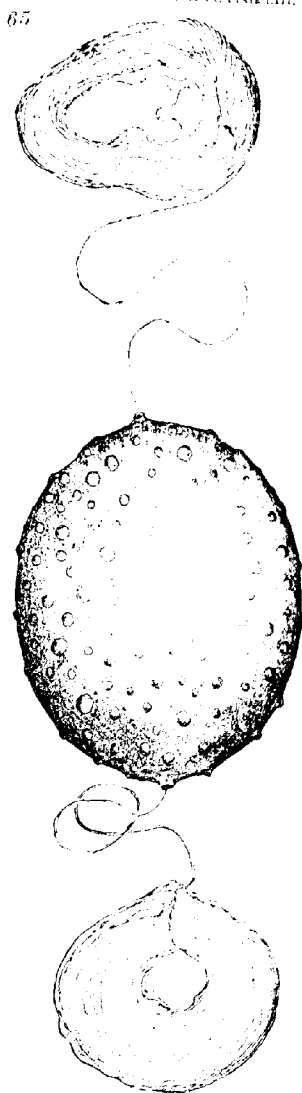


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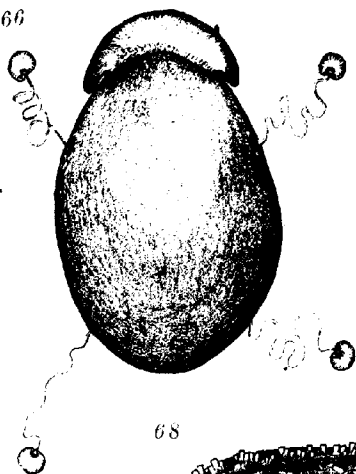




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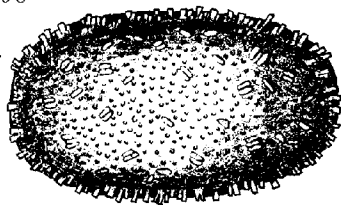
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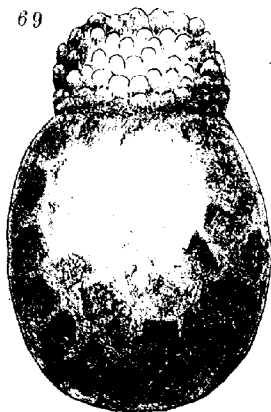
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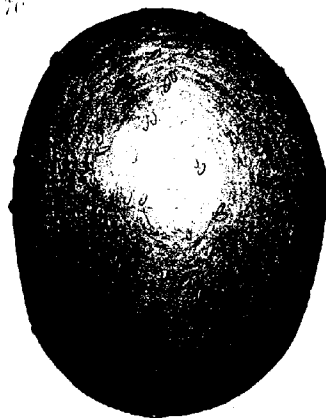
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